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# POWER

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# What is a Foot?

OUR metriphobic contemporary *Weight and Measure*, organ of the American Institute of Weights and Measures, consecrated to the preservation of the sanctity of the English System, emits a discordant note because the Test Code of the American Society of Mechanical Engineers defines the foot and the pound by reference to the international prototype meter and kilogram. Listen:

> The two latter are specially favored by being assumed. Why should, then, the foot and the pound be singled out for definition? Why are not these of sufficient standing to be assumed also? They have the right of priority over the meter and the kilogram and the right by universal use in the United States today, whereas the meter and the kilogram are still foreign units. We recommend that in future editions of the Codes the foot and the pound be accorded the respect which is their due and be not defined at all.

This from a presumed authority on weights and measures!

You buy a rule from a maker of standard gages; I buy one in a five-and-ten-cent store. If they are alike it is a miracle.

Which is a foot, yours or mine?

The maker of the standard rule did not invent the foot or fix the value of its length. He had to know what a foot was before he could make a foot rule.

Koebel's work on Engineering, published in the Sixteenth Century, gives the following directions for finding it:

> To find the length of a rood in the right and lawful way according to scientific usage, you shall do as follows: Stand at the door of a church on a Sunday and bid sixteen men to stop, tall ones and small ones, as they happen to pass out when service is finished; then make them put their left feet one behind the other, and the length thus obtained shall be a right and lawful rood to measure and survey the land with, and the sixteenth part of it shall be a right and lawful foot.

The only action that the government of the United States has taken to fix the length of the foot is an Act of Congress of July 28, 1866, which makes the international meter equal to 39.37 inches. The old Kater relation of 1818 was 39.37079 and is still, I believe, in use by one of the leading American makers of gages.

A code must define the value of the units that it uses. How can it define the value of the foot otherwise than by reference to the only act of the only body that has spoken with authority upon the subject?

F. R. Low

## Organizations Versus Men in American Industry

CRITICISM has been made abroad that American industry, in its preoccupation with organization, neglects the benefits that flow from the development of leadership by outstanding men. Perhaps it does appear so from a distance, for our organizations are tremendous things. But it has been said, and with much justice, that these are but the lengthened shadows of men.

Anyone with more than a passing acquaintance with industry must be aware of the time and effort spent by successful executives to obtain and train men capable of constructively leading the organizations that they have built. Far from considering the organization as sufficient in itself, they well know that the whole thing stands or falls in accordance with the qualities of its leaders.

Therefore the beginner in the engineering field can look forward with confidence to the future. If he has the right stuff in him, his path to the top should not be too difficult. Though American manufacturing companies do not yet have executive groups made up entirely of Ph.D. engineers, as is sometimes the case in Germany, they have need of the best men obtainable for these places. And the engineer's special qualities are being more and more recognized as of value for such work.

## More Standardization in Smoke Prevention

RENEWED activity in smoke elimination is noticeable among many municipalities. Some have employed competent engineers to study the local problems and work out the solutions; others have entrusted the work to local health departments with varying degrees of success.

While these efforts, on the whole, have resulted in less smoke, the methods employed have differed in many cases in accordance with the individual views of local authorities. This applies especially to boiler settings, including height above grates, length of dutch ovens, arrangement of arches, etc., and creates a problem for the boiler manufacturer. Not only does it necessitate his keeping in close touch with the desires of various municipalities, but it is often a source of annoyance in production.

For each class of coals there is a best method of preventing smoke. Let this be agreed upon and accepted by the numerous smoke enforcement officers. They already have a point of common contact in the National Smoke Prevention Association, which meets once a year and has done excellent work in promoting smoke-prevention activities.

## A New Process for Making Wrought Iron

FOR years wrought iron has been made by the laborious process of puddling in a furnace, which limited production to batches of not more than a quarter of a ton and which left the quality largely dependent upon the skill of the puddler.

Efforts have long been directed to developing mechanical means of accomplishing the same results, and until recently there has been no promise of success. Now, however, one hears about the Aston process, which, it seems, consists in refining the metal in a bessemer converter and pouring it into a body of molten slag. The resulting product is said to be the same as hand-puddled wrought iron, with fine particles of slag distributed uniformly throughout the finished metal.

As a piece of news this will interest the power-plant engineer, because there are uses for which wrought iron is preferred by many people.

The development is also interesting as an illustration of the fact that in the development of mechanical processes to displace hand labor, the successful process is not often the one which closely mimics the hand operation, but often bears no resemblance whatsoever to it. As an inventive genius recently remarked, if one desires to devise a mechanism for doing something that has previously been done by hand, the very worst thing he can do is to attempt to imitate the motions of the human hand. Success in the application of mechanical processes demands a masterful familiarity with mechanism rather than a close study of animal anatomy.

## Branded Coal Should Help Consumers

SINCE mention was made some weeks ago in these columns, of the Scranton venture in blue-dyed coal, a Reading company has come forward with purple coal. Whereupon the daily press is moved to levity and articles appear recommending that ribbon clerks be engaged to sell coal and making references to Gelett Burgess's famous purple cow.

But, seriously, there is more than the germ of a good idea in this move. Coal, as engineers know to their sorrow, may be almost anything that will hold together long enough for shipment without completely disappearing into thin air. As an aid to the small buyer who wants to buy a fuel that can be depended upon to fulfill certain specifications, the coal-branding movement is a forward step. When the coal-producers and dealers' success becomes dependent upon the quality of an easily recognized, trademarked fuel, the user can make his purchases with more confidence. And, to the benefit of both, the days of the inefficient producer of poor quality coal will be numbered.

## Lack of Engineering Foresight

ONE often marvels at the lack of foresight on the part of engineers of past years. For instance, in 1910 a leading engineer in discussing steam-turbine development wrote as follows:

> The limitation of the reciprocating steam engine may be safely placed at 6,000 kilowatts normal rating, this being the largest ever built. The steam turbine, on the other hand, has been built in sizes nearly three times this capacity with at least one order placed for a machine of 18,000 kilowatts capacity. The capacity limit would, at present, be hard to predict. It is felt that a machine of 25,000 kilowatts normal rating should fill every requirement and at the same time reach the limitations in construction and installation. In a machine of this size it would be necessary to handle pieces approximately one hundred and fifty tons in weight and the machine would probably exceed five hundred tons in total weight. Thus it will be seen that the problems of machine work and erection border upon the most difficult if not the impossible.

Ten years ago a speaker at an A.S.M.E. meeting was laughed at when he proposed the use of steam turbine units of 100,000 kilowatts capacity.

In view of the placing of orders for turbine units of

108,000 kilowatts, 165,000 kilowatts and 208,000 kilowatts capacity each, the preceding statements seem now to be amusing and to be good examples of lack of imagination and foresight.

Are present-day engineers entirely free from these faults? Certain sizes of boilers, furnaces, condensers, etc., are considered as approaching the limits of possibility in the eyes of certain engineers. Will the judgment of these engineers appear as limited in twenty years as that of the writer quoted? Is it not possible that our present ideas of boiler and furnace construction will be superseded by new and radical designs? Will we appear unduly timid in our use of high steam pressures and superheats?

## Can the Engineer Help the Banker?

IF ANYONE put forward the proposition that every engineer should have a banker, general agreement would follow. But the converse, that every banker should have an engineer, might not be so readily accepted. Many bankers would doubt its truth, while most engineers have never given the matter any thought. Yet the statement is correct—more so today, perhaps, than ever before.

The rate at which new inventions and mechanical improvements develop, in the power plant and elsewhere in industry, is greater now than in the past. All too often, in the resulting confusion, the financial man tends to back the wrong horse. Money that is needed for sound, legitimate projects, sometimes goes to back the scheme that is unsound for engineering and economic reasons. Can the great amount of money invested in low-temperature carbonization experiments, for instance, be justified? In many cases an unbiased engineering study would show that it could not. Similar situations exist in other fields, and the power field is no exception.

The engineer can be more useful in preventing such wasteful operations than the banker realizes. His training and experience cause him to judge each new project by the dollars and cents standard. Economy of operations is his great goal, and if a proposed innovation does not hold real prospects for profit or saving, he will have nothing to do with it.

The banker, however, is unlikely to change his viewpoint unless pressed from outside. The engineer must demonstrate the value of his counsel. Here is an opening for some capable engineers. They can not only develop good positions for themselves in this field, but they can, at the same time, serve the public at large by helping to put its surplus funds to better use.

## Modern Machine Design

WHEN steam engines were the usual type of prime mover, designers were interested principally in securing sufficient strength to carry certain sustained loads. They used factors of safety applied to the ultimate strength of the material to determine allowable working loads which were well below the elastic limit of the given material.

The development of high-speed turbine-generators and other equipment has quite changed the problem. While one is still interested in the tensile strength of the material, new phenomena occur, such as fatigue, accelerated by the rapid changes of stress due to high speed or vibration, and changes due to subjecting metals to high temperature. Designers also have critical speeds to consider. The fatigue limits of materials must be known. A still newer phenomenon is that characteristic known as corrosion fatigue, where fatigue failures are accelerated by the corrosion of the metal under stress. In dealing with high temperatures, one also must consider the creep of the metals, as well as their resistance to corrosion under such temperatures.

These are all new problems unfamiliar to the older designers and in fact inadequately treated in most courses and textbooks on machine design. These books deal largely with problems involving static loads, while most modern machinery must be designed with consideration of dynamically induced stresses. Modern textbooks should show the application of dynamical theory to modern machine design.

Referring to fatigue phenomena, little is known concerning their nature. A fatigue failure of a machine part presents a fracture from which at the present time little can be learned by an examination of the break. Possibly an extended study of these breaks would lead to the formulation of certain standards by which it would be possible to study other breaks and to learn the nature of the stresses that led to their formation.

## Electric Meters Reveal Profits and Losses

A STUDY of the electric power circuits is one of the most prolific and profitable sources of information on the condition of the power equipment and on the way the manufacturing processes are being conducted. To insure reliability of the electrical circuits and equipment, it is necessary to know their condition. Weakening of the insulation will be detected if periodic insulation resistance tests are made and records kept. In some plants the large motors and their circuit equipment are checked each week to make sure that they are always ready for service.

Contrary to the general idea that circuit insulation cannot be in a condition to allow a considerable current leak without causing a short circuit, heavy power losses have occurred through the insulation of feeders. In one instance, where the distribution lines were run in wet places and neglected, it was found that a one-hundred ampere leak existed without the plant operators and management being aware that anything was wrong. Needless to say, such a condition cannot develop if proper attention is given to the insulation of the system.

A second feature of a study of electric circuits is the possibility of power saving in motor drives, revealed by such investigations. The proper use of meters brings out information that cannot be obtained in any other way. This information tells a story not only of the electrical equipment but of the whole process connected with the motors. A record of the power consumption may even show the habits of those entrusted with handling the operations. When it is necessary to place the responsibility for some fault, a record of the power to the process has frequently supplied indisputable evidence.

The stories that a record of power input tells are as varied and as limitless as the possibilities for making the studies. Frequently, the conditions revealed are entirely foreign to what had been expected. In this way the record discloses many things that would otherwise go unnoticed.

# THE COAL-DUST ENGINE
## *Upsets Traditions*

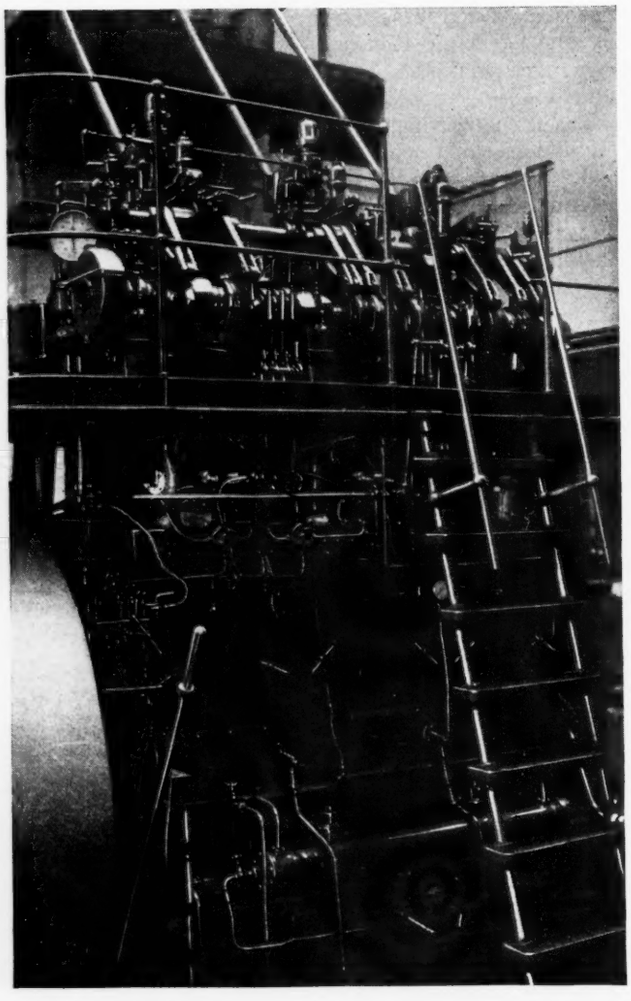
By
R. PAVOLIKOWSKI

AFTER 15 years of development an engine burning pulverized coal directly in the cylinder is in commercial operation.

Most engineers have believed that it was not possible to burn coal inside of an engine cylinder; for this reason the possibilities of the pulverized-coal engine have been treated lightly even by those building internal-combustion engines. But such an engine is commercially possible, and its four years of operation should explode all the doubts held by the public.

In 1911 the Kosmos Machine Works, of Goerlitz, Germany, began its investigation and experiments on a pulverized-coal engine, but was unable to obtain dependable ignition until 1916. This was finally accomplished in a vertical 16½x25-in. single-cylinder M.A.N. four-stroke-cycle engine built in 1906. This engine was rated at 80 b.hp. when operating at 160 r.p.m. Until 1916 it had been in regular operation as an oil engine in a chemical plant and the cylinder had worn about 0.04 in. near the head end. After the necessary changes were made, it was found that the engine operated entirely successfully with pulverized coal, without depositing ash or slag inside of the cylinder, and that the wear was well within the permissible commercial limits. It operates equally well with pulverized coal or oil or with a mixture of the two. It is still in operation and furnishing power to the factory. It is still obtaining its initial compression of 440 lb. abs. and delivers one brake horsepower on 8,000 B.t.u. of pulverized coal. For twelve years it has operated with nearly all grades of German anthracite and burns coals, turf, sawdust, charcoal, rice dust, flour and even coke.

*Fig. 1—A three-cylinder Diesel arranged with pulverized-coal attachments*



The pulverization of the coal must be at least as fine as that required for boiler-furnace firing, and the degree of fineness must be increased proportionately with low-volatile, high-ash coals. Experiments have shown that coals that are hard to ignite can be burned successfully, but that better results are obtained if they are ignited with gasoline or activated coal during the brief time period allowed for ignition. Even hard coal with an ash content of 16 per cent gave excellent results when mixed with 20 per cent of pulverized brown coal. This achievement was demonstrated before Professor Bosch during 1926. Other demonstrations were witnessed by hundreds of engineers, among them being Professor Klingenberg.

The engine was started with all the fuels mentioned, and was operated with a brake load and in regular service. It developed a maximum of 120 hp. at that time. After continuing in daily operation for three years without repairs, the slight wear is proved by the fact that it delivered 110 b.hp. during a recent braking test. This represents a brake m.e.p. of 113 lb., corresponding to an indicated m.e.p. of 142 lb. at 80 to 84 per cent mechanical efficiency.

The maximum indicated m.e.p. developed with the various kinds of coal and with 500 different nozzle designs, ranged between 162 and 167 lb., with a pressure of only 53 lb. abs. at the end of the expansion. The heating value of the coal is converted into power as efficiently as that in the oil by a Diesel engine.

The fine solid particles of coal evidently penetrate the entire volume of combustion air compressed within the cylinder to 440 lb. abs., more readily than minute vaporized oil particles, which evaporate and break up when they strike the air.

It has been conclusively proved that a properly designed combustion chamber will cause the individual particles of ash to remain suspended in the combustion air without caking or slagging on the piston, cylinder, valves or port surfaces. They are expelled with the exhaust.

When delivering 87 b.hp the engine consumed 80 lb. of pulverized brown coal, which can be purchased in Germany for about 9 cents. This coal contains about 10 per cent of ash; therefore only about 0.0005 lb. of ash is discharged for each cubic foot of piston displacement. The exhaust is free from all combustible and appears as a light brownish haze. It has not even smudged a 30-ft. wall only a few feet away. No tar has been found either in the exhaust or in the used cylinder oil.

The operation may be described briefly, as follows: The required amount of pulverized coal for the next working stroke is segregated by the governor and is hurled by an excess pressure into the compressed combustion air at 440 lb. abs. inside of the cylinder. This takes place within a suitable hurling chamber located ahead of the cylinder, which is shown in Fig. 2. The coal is drawn into this cylinder by exhausting the air, whereupon the chamber is sealed against the outside and the coal is blown or hurled into the cylinder. The necessary excess pressure to blow the coal may be obtained from an air compressor or by partly advancing the ignition in the chamber. The hurling chamber may be permanently open to the cylinder or it may be connected with the latter through an admission valve. Both methods have proved equally successful. The open port chamber is simpler and has the additional advantage that it is subjected to the same variations in pressure as the cylinder, which in turn makes it possible to fill the hurling chamber with coal by the suction of the piston. Further, the combustion air enters the chamber during the compression stroke, which increases the time period allowed for mixture and results in more rapid ignition. The open port chamber is, therefore, appropriate for high-speed engines.

Contrary to the Diesel engine, the pulverized-coal engine compresses the fuel and combustion air simultaneously, but keeps them separated until ignition occurs. Therefore, it improves the Diesel cycle at its weakest point, namely, that the incoming fuel oil must be heated and ignited in the extremely short period afforded by the fraction of a single stroke. The pulverized-coal engine extends this time to at least one full stroke, making it about ten to fifteen times as long as is possible with the Diesel. As this engine will also operate with oil fuel and without an air compressor, it would be possible to build an engine to burn either oil or coal, depending upon which was the cheaper fuel.

With regard to lubrication no ash must be permitted to penetrate between the piston and cylinder wall. This is avoided by admitting clean compressed air at 880 lb. between the piston rings, to fill the spaces along the piston, immediately before ignition takes place. With this piston air seal the 80-hp. engine has operated for years. It was possible to continue operation with the original piston rings from 1916 to 1924. At the end of that time the cylinder had worn only 0.08 in. Since then other and less complicated methods of sealing the piston rings have been devised.

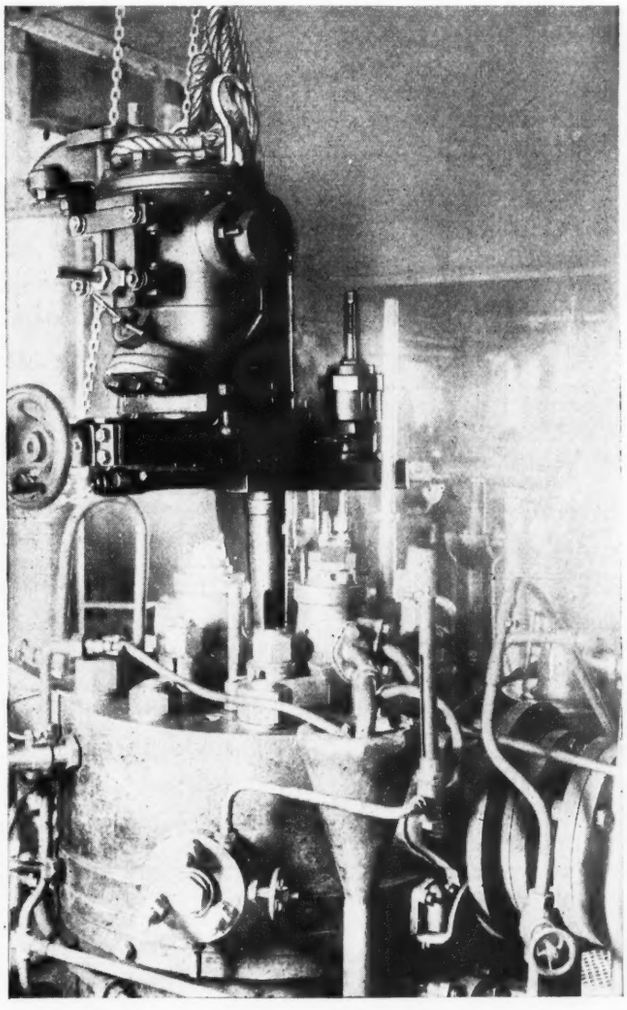
The pulverized-coal engine consumes more lubricating oil than a Diesel. This is due to the fact that it is desirable to keep the ash flushed from all surfaces. The used oil is black in color, but is easily purified for re-use.

Engineers who ran a brake test on the engine for several days discovered that about 0.13 lb. of oil was consumed per hour, and that 8,000 B.t.u., or 0.91 lb. of brown coal, was required per brake horsepower-hour at normal rating.

Rapid wear has been said to be the most serious objection to the pulverized-coal engine. The 80-hp. engine was carefully examined for wear during its twelve years of operation. It is still operating with its original piston and cylinder lining, built in 1906, without requiring reboring of the cylinder. The hardness of the liner, according to the M.A.N. reports, is only 120 Brinell gage, whereas modern liners possess hardness of 220-280. In spite of the hard usage appreciable wear is evident only for a distance of seventeen inches at the upper part of the cylinder. The lathe tool marks are still discernible in the lower part of the cylinder. The compression pressure obtained is 440 lb. abs., and ignition takes place solely by the compression temperature making it possible to start and operate the engine with pulverized coal. A conservative estimate indicates that the engine has been in actual use for 9,000 hours with pulverized coal. The wear cannot, therefore, be considered commercially prohibitive.

The remaining details, such as the divided filling valve, the governing, the path of the pulverized coal, the preheating of the pul-

*Fig. 2—The combustion chamber withdrawn from the cylinder*



verized coal by the exhaust, the simple feeding of multi-cylinders by a single filling accessory, can be ascertained from the patent papers.

Operation has shown that in Germany one brake horsepower-hour can be delivered at a cost of 0.12c. with pulverized coal, whereas the cost with oil would be about 0.45c. Therefore, the savings amounts to about 80 per cent. For a 1,000-hp. engine operating 3,000 hours per year, this will total about $10,000.

### Diesel Advantages Retained

The cost of building a pulverized-coal motor is no higher than that of an oil engine of equal capacity. Pulverized coal can be purchased in unlimited quantities. All Diesel engine advantages are retained. No outside

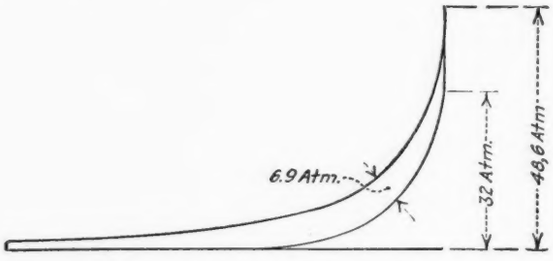



*Fig. 3—A typical indicator diagram from the pulverized coal engine*

service of heat is required to start the pulverized-coal engine. The engine is compact and easy to build. It is from 30 to 35 per cent more efficient than the most efficient steam turbine and delivers power at a lower cost than any other fuel-burning prime mover.

The simple and compact design of the pulverized-coal hurling chamber is shown in Fig. 2 where it is suspended from a crane, ready for lowering into the bore of the former fuel-oil valve cavity.

The diagrams in Fig. 3 were taken while the engine was being given three air charges, followed by ignition within the engine of pulverized brown coal.

The diagrams in Fig. 4 were taken by Professor Haeusser, of Dortmund and show 50 ignitions with and without admission air. All 50 ignitions are super-

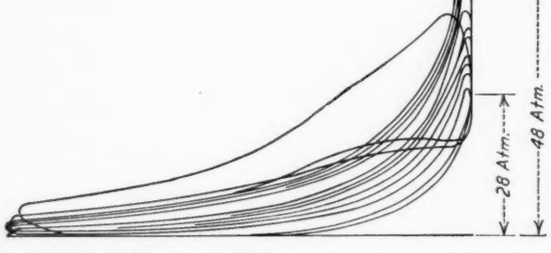



*Fig. 4—Superimposed diagrams showing the governing regulation*

imposed, which prove that the governor accurately subdivides the pulverized-coal charges and that ignition was obtained at all loads.

In conclusion it is interesting to observe that 60 years ago Doctor Otto invented his gas engine, utilizing the lightest of all fuels. Thirty years later, Dr. Rudolph Diesel brought out the Diesel engine, which utilizes fuel oil. Now, 30 years later, the pulverized-coal engine is all ready to play an important part in industry.

# WHAT DO YOU KNOW?

By L. H. Morrison

*The answers are on page 145*

Ques. 1—What is meant by the "duty of a steam pump"?

Ques. 2—What is the purpose of a shaft sleeve on a centrifugal pump?

Ques. 3—In a certain plant a single motor is used to drive a centrifugal circulating and a centrifugal sump pump. Is it safe to operate this with the sump pump running empty?

Ques. 4—When a ball thrust bearing is mounted on the shaft of a turbine to keep the rotor in a definite location, should the bearing at the same time carry any of the rotor weight?

Ques. 5—Can as much power be obtained by expanding steam at atmospheric pressure to 29 in. of vacuum as from steam at 150 lb. gage pressure expanded to atmospheric?

Ques. 6—What is the thermal efficiency of an engine?

Ques. 7—What is meant by the "Rankine cycle"?

Ques. 8—On the pressure-volume diagram what are the boundary lines of the Ericsson hot-air cycle?

Ques. 9—If into a bottle containing nothing but dry air water at 180 deg. F. is poured and the stopper quickly inserted, what pressure would you expect to be registered after the bottle is shaken violently?

## MAKE OR BUY?

*Sometimes It Pays to Do Both*

Some engineers have little use for the type of plant that purchases most of its current, but generates a small amount. They think it best to do all of one or the other, feeling that they thus avoid undue complication.

However, many opportunities for really substantial savings lie in the following of this procedure. The Seamless Rubber Company of New Haven, Conn., recently worked out such an installation, to its great advantage. Warren P. Smith, maintenance engineer of that concern, tells the story in *Power,* July 31, 1928.

# *What It Costs*
# To Generate Industrial Power

By W. D. Canan
*Rust Engineering Company, Pittsburgh, Pennsylvania*

***Forecasting the cost of industrial power is no mean problem. The curves and methods given in this paper, first outlined by the author before the Scranton meeting of the Lehigh section of the A.I.E.E., in March, will aid anyone faced with the problem***

AN ANSWER to the question how much it costs to produce a kilowatt-hour of energy in an industrial electric generating station cannot be easily given with any great degree of accuracy. However, consideration of the various factors making up this cost, together with data arrived at by rather simple mathematical calculations and a study of the performances of equipment of a type and size likely to be installed, will enable one to get a fair approximation of what this cost will be.

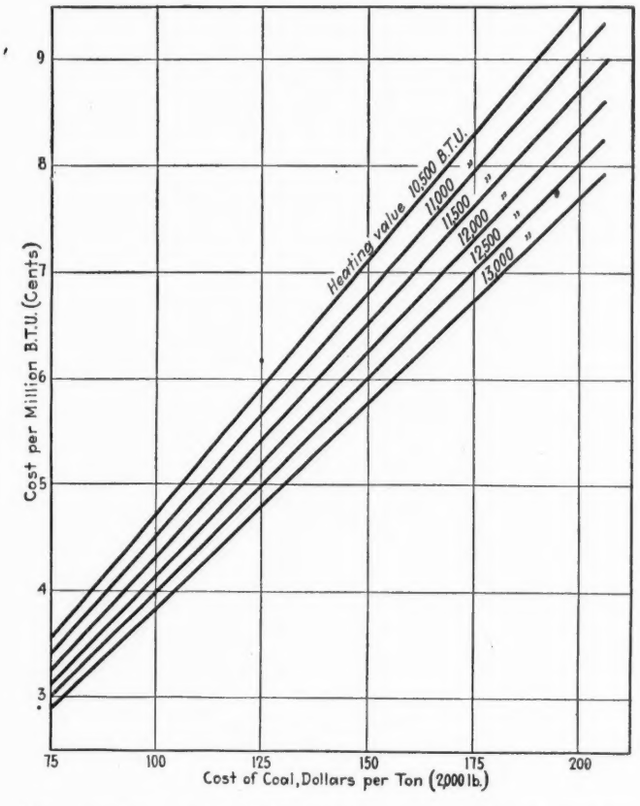



*Fig. 1—Cost per million B.t.u. from coal of various qualities and prices*

The items entering into the cost of power are usually grouped under two main headings—the operating cost and the fixed charges. The operating cost is again subdivided into fuel, labor and maintenance cost. In this paper coal is the only fuel that has been given consideration. The various factors affecting the cost of fuel are the cost of the coal delivered at the plant, the heating value of the coal and the combined boiler efficiency and the over-all efficiency of the generating unit. The factors affecting the labor cost are local labor conditions, type of plant, size of plant, kind of fuel burned and load factor. The factors affecting the maintenance cost are character of labor, type of equipment, kind of fuel burned, per cent rating carried on equipment, and load factor.

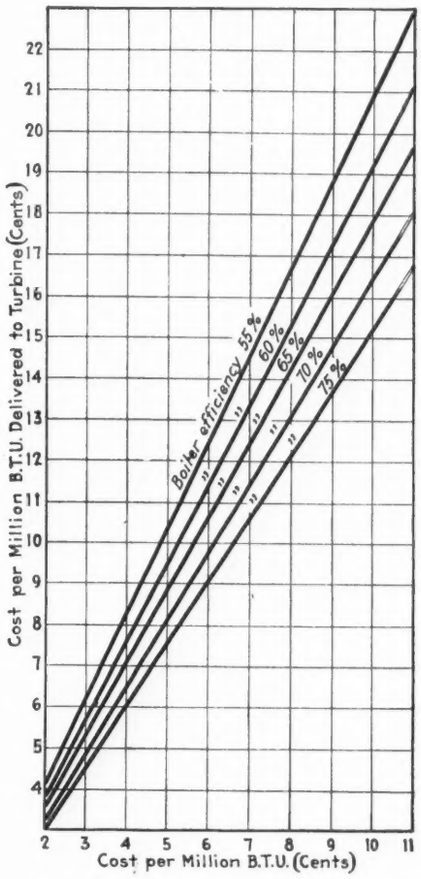



*Fig. 2—Cost per million B.t.u. delivered to the turbine at various coal costs and boiler efficiencies*

Of the subdivisions of operating cost, the one subject to the greatest variation is the fuel cost. The curves in Figs. 1 to 5 have been plotted so that the fuel cost for

a particular assumed condition may be quickly determined. These curves will be used later in working out a specified example.

Under the general heading of fixed charges there usually are four principal subdivisions: Interest, taxes, insurance and depreciation. The first three are more or less fixed and independent of the plant or its method of operation. The fourth factor, however, that of depreciation, is affected, so far as the cost of production of

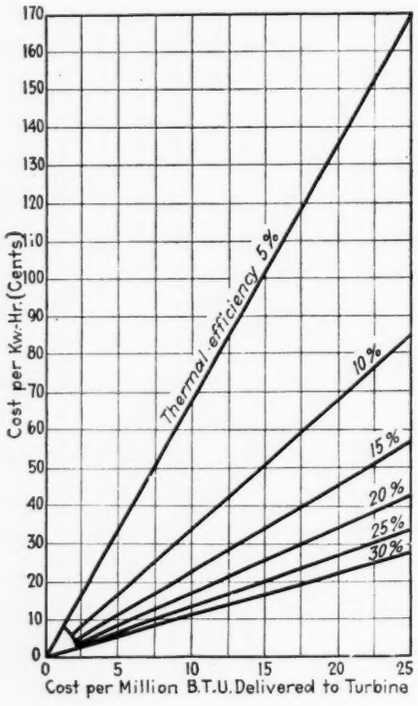



*Fig. 3—Fuel cost per kilowatt-hour, at varying turbine efficiencies*

energy is concerned, by the initial cost of the plant and the load factor.

The use of the curves in determining the cost of energy can be illustrated by the following example: Assuming a plant where coal having a heating value of 12,000 B.t.u. can be bought for $1.50 a ton delivered, the average boiler efficiency being 70 per cent, and that a 1,500-kw. turbine will be used operating at 200 lb. pressure, 28 in. vacuum and no superheat, the average load would be 1,250 kw. and the cost of the plant $125 per kilowatt.

### Cost per Million B.t.u. Delivered

Referring to Fig. 1, we find that the cost per million B.t.u. delivered in the coal will be 6.25c., and referring to Fig. 2, we find that the cost per million B.t.u. delivered to the turbine will be 10.20c. The efficiency factor for this size machine works out to be 10 per cent, and reference to Fig. 3 shows that the fuel cost per kilowatt-hour will be 0.35c. Labor cost for plants of this size vary from 0.10 to 0.20c. and the higher figure has been assumed. Maintenance has been assumed as 0.05c., making a total operating cost of 0.60c. Referring to Fig. 4, we find that the fixed charges for a plant that costs initially $125 per kw. and operates at 35 per cent load factor, will be 0.60c. This makes a total cost, under these conditions for generating a kilowatt-hour of energy, of 1.20c.

The foregoing example is worked out on the assumption that the plant is to be used for electric generation only. However, in case there is a use for process steam which might be extracted at some point in its expansion from the initial to the final condition, or if the turbine would exhaust at some pressure at which the steam could be used for process work or driving auxiliary low-pressure equipment, then the cost of producing the electrical energy would be reduced in direct proportion to the heat used for the two purposes. As an example, assume that in its passage through the turbine only 25 per cent of the heat energy was used for making electrical energy and the remaining energy used in some process work; then it is quite evident that only 25 per cent of the total cost of producing a kilowatt-hour of energy, or 0.30 of 1c. should be charged off to electric generation.

### Modern Equipment and Methods Possible in Small Plants

Owing to recent developments it is now possible to use in the small industrial power plant much of the modern equipment and methods used in the larger central stations for the economical production of electrical energy. Much advancement has been made in the last few years in the use of higher steam pressures and super-

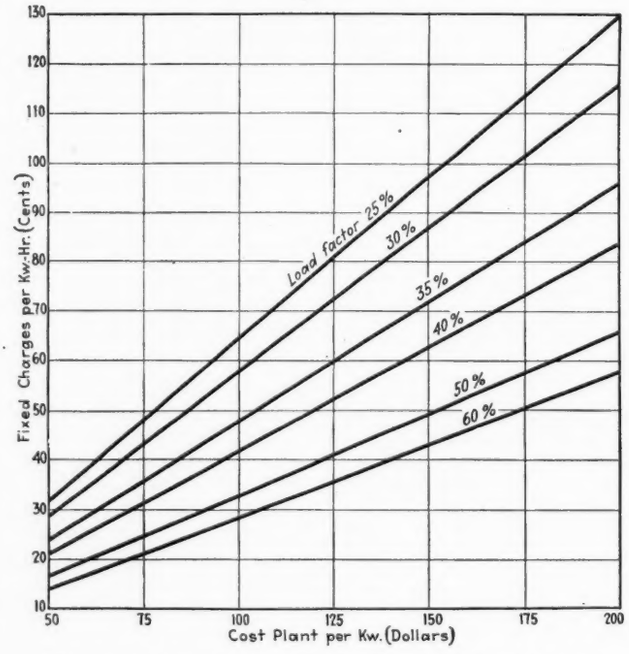



*Fig. 4—Variation of fixed charges with load factor and plant cost*

heats. This change in initial steam conditions results directly in a decreased steam consumption of the generating units, as shown in Fig. 5, together with a reduction in size of the boiler, the auxiliary equipment and the plant as a whole. High steam pressures also make it possible to extract or bleed steam at comparatively high pressures for process work or use in present low-pressure equipment. The trend toward higher pressures has been so marked in the last few years that it can be safely said that no one who is at present considering the installation of boiler equipment should fail to investigate the possibility of using steam pressures of 375 lb. or above.

In the design of an industrial power plant cost of the

completed job is of prime importance, not only because it has so great an influence on the cost of producing electrical energy, but also because it may influence prospective builders to abandon the idea owing to difficulties of financing the project. It, therefore, becomes extremely necessary in giving preliminary consideration to such a project to study and consider thoroughly the factors that determine the cost of the plant. First, we have the type of plant to be built, whether or not its principal function is that of a heating or process steam plant as compared to one to be used exclusively for the

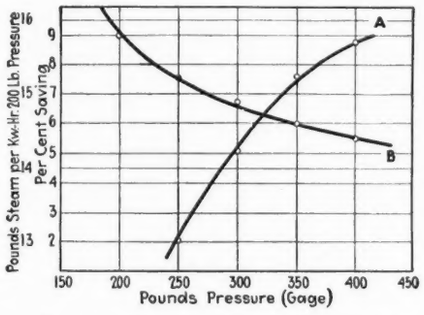



*Fig. 5—Steam consumption and per cent savings for various steam pressures*

generation of electrical energy. In this connection other points to be considered are whether the plant will be used as the principal source of power or for stand-by service only. If the plant is an entirely new proposition, the problem would be somewhat different from what it would be were it merely an addition to an existing plant.

A study of the location, particularly with reference to the accessibility of the site, the nature of the ground and the architectural features of the building, is very necessary. Items that can be determined only after considerable thought has been given to the type and character of load to be handled, are as follows: Size of plant, the most economical steam pressure to be carried, character of fuel to be burned, cost of fuel and load factor.

TABLE I.—BOILER HOUSE UNIT COSTS

Dollars per b.h.p. for various size plants

| Item | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| Rated boiler, hp. | 2–350 | 3–410 | 4–500 | 3–490 | 3–500 | 3–668 | 3–746 |
| Per cent rating.. | 200 | 300 | 200 | 400 | 250 | 200 | 400 |
| Boilers..... | $20.00 | $52.00 | $26.00 | $35.00 | $20.00 | $24.00 | $55.00 |
| Stokers..... | 9.00 | ..... | 8.00 | 14.00 | 16.00 | 12.00 | ..... |
| Pulverizers..... | ..... | 20.00 | ..... | ..... | ..... | ..... | 30.00 |
| Fans..... | 1.00 | 2.00 | Included in boiler item | 4.00 | 2.50 | 2.00 | 8.00 |
| Brickwork..... | 8.00 | 11.00 | 8.00 | 10.00 | 13.00 | 8.50 | 12.00 |
| Soot blowers.... | 1.50 | 2.00 | Included in boiler item | 3.00 | 2.00 | 2.00 | 3.00 |
| Superheaters.... | ..... | 3.00 | Included in boiler item | 4.00 | 4.00 | 3.00 | 3.50 |
| Combustion control..... | .80 | 2.50 | 3.00 | 2.00 | 2.00 | ..... | 2.00 |
| Air preheaters.. | ..... | ..... | ..... | 13.50 | ..... | ..... | 7.00 |
| Feed heaters.... | 1.50 | 1.25 | 1.00 | 4.50 | 2.25 | 1.00 | 9.00 |
| Feed pumps..... | .50 | 2.00 | 1.75 | 4.50 | 3.00 | 1.50 | 5.00 |
| Piping..... | 13.00 | 20.00 | 10.00 | 30.00 | 15.00 | 8.00 | 23.00 |
| Coal handling... | ..... | 7.00 | 6.50 | 12.00 | 10.00 | 7.50 | 8.00 |
| Ash handling... | ..... | 3.00 | ..... | 5.00 | ..... | 3.25 | ..... |
| Chimney..... | 10.00 | 12.00 | 9.00 | 3.00 | 12.00 | 6.00 | 8.00 |
| Breeching..... | 2.00 | 4.00 | 1.50 | 3.00 | 3.00 | 1.00 | 5.00 |
| Building..... | 20.00 | 40.00 | 25.00 | 23.00 | 30.00 | 15.00 | 35.00 |
| Engineering..... | 4.00 | 7.00 | 5.00 | 8.00 | 6.00 | 3.00 | 10.00 |
| Miscellaneous... | 6.00 | 8.00 | 9.00 | 15.00 | 10.00 | 5.00 | 20.00 |
| Total per rated hp..... | $97.30 | $196.75 | $113.75 | $193.50 | $150.75 | $102.75 | $243.50 |
| Total per dev. hp..... | 48.65 | 65.58 | 56.87 | 48.37 | 60.30 | 51.38 | 60.87 |

One factor which is often not considered, yet which has a great influence upon the ultimate cost of any plant, is that of the experience and responsibility of those undertaking its design and construction.

In the final design of a plant outside of the matters that refer particularly to the thermodynamics of the problem and details of the equipment, experience indicates that there are a great many details that would ordinarily be considered of minor importance but that have a tremendous influence upon the successful operation of the plant after it is once built. These details cover a wide range and are difficult to enumerate. However, our own experience indicates that the following items should be given special consideration.

### Basement at Ground Level Desirable

First, if the site selected for the plant will permit, it is extremely desirable to provide a basement at ground level. Second, all the equipment should be provided with ample space around it. This point is often overlooked, especially in the drafting room, where the only knowledge of the equipment which the men have is that which is obtained from blueprints and other illustrations.

TABLE II.—GENERATOR HOUSE UNIT COSTS

Dollars per kw. for various size plants

| Item | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Rated kw..... | 1–600 | 1–750 / 1–1500 | 2–5000 | 3–1000 | 1–6000 | 2–1500 |
| Engine generator..... | $46.50 | ..... | ..... | ..... | ..... | ..... |
| Turbine-generator..... | ..... | $22.00 | $19.00 | $26.00 | $15.00 | $22.00 |
| Condenser and auxiliaries | ..... | 5.00 | 4.25 | 6.00 | ..... | 3.00 |
| Piping..... | 5.00 | 4.00 | 1.50 | 7.00 | 3.00 | 2.50 |
| Switchboard..... | 7.50 | 4.00 | 3.00 | 5.00 | 2.00 | 5.00 |
| Crane..... | 1.00 | 1.00 | 1.25 | 1.00 | .50 | 1.00 |
| Building..... | 15.00 | 6.00 | 3.00 | 10.00 | 5.00 | ..... |
| Engineering..... | 2.00 | 4.00 | 4.00 | 3.00 | 2.00 | 3.00 |
| Miscellaneous..... | 3.00 | 2.00 | 9.00 | 5.00 | 10.00 | 7.00 |
| Total per kw..... | $80.00 | $48.00 | $45.00 | $63.00 | $37.50 | $43.50 |
| Total cost power plant, kw..... | 200.00 | 160.00 | 75.00 | 151.00 | 127.00 | 100.00 |

Third, there should be an abundance of light, both day and night. Fourth, proper ventilation for basements and especially the boiler room is vitally necessary. Fifth, be sure that the stack in case of a natural-draft installation, is of the correct capacity. Proper allowance should be made for future expansion, as the stack, in case of a radial brick or concrete structure, is about the only thing in connection with the plant that it is impossible or at least impractical to add to. On the other hand, there is danger of getting the stack too large, so that when the plant is operating on light loads, insufficient draft will be produced owing to the slowing up of the gases and resulting cooling of the chimney. Sixth, considerable thought should be given to a selection of the proper size and number of main units and the auxiliary equipment. Upon the proper selection of this equipment depends to a considerable degree the economy of the plant when considered over a long period of time. Seventh, special consideration should always be given to the piping with regard to the layout, kind and number of valves used, insulation and provision for expansion.

Finally, it is of greatest importance that complete plans and specification of the complete project be prepared before any considerable amount of actual construction work is done. We have had numerous examples of starting in on projects of this nature before having had an opportunity to prepare complete plans and specifications, and invariably it has resulted in increasing the cost, delaying the final completion and not giving so good a job as might have been obtained.

# Wood Refuse Burning Over Underfeed

TO KEEP pace with the rapidly increasing demand for automobile wheels and bodies, the Budd Wheel Company, of Detroit, early in 1926 decided on an addition to the power plant. The original plant, built in 1925, housed two 5,000-sq.ft. boilers, which soon proved inadequate, so that two boilers, each having 12,500 sq.ft. of surface, were incorporated in the new design to take care of present requirements, and at the same time provision was made for further expansion.

Primarily, the plant generates steam for heating and process and for such steam-driven auxiliaries as are necessary to obtain a proper heat balance within the power house. The electrical power requirements are supplied by central-station service and compressed air from motor-driven compressors in the power plant. With the new addition two compressors, each of 2,500 c.f.m. capacity, with inter- and after-coolers and driven by 800-hp. motors, were added to the initial installation.

Reference to the accompanying sectional elevation of the plant and to the table listing the new equipment will show that a modern installation has been provided. The new boilers are of the three-pass, bent-tube type, with a furnace volume approximating 4,200 cu.ft. They are set singly and equipped with 11-retort underfeed stokers provided with steam-operated ash dumps and turbine drives. Normally, they will operate at 125 lb. gage pressure with no superheat. The settings are provided with air-cooled walls with perforated block construction at the front and sides along the fuel bed and, to improve combustion and prevent slagging and clinkers, two rows of perforated block in the bridge wall just about the dump plates. Forced draft to the main air box under the stoker is supplied through ducts under damper control and separate dampered ducts supply the air-cooled walls.

The addition to the power house required extension of the overhead coal bunker and of the coal- and ash-handling system installed for the original plant. As indicated in the sectional view, the coal is delivered from cars into a track hopper and by an apron conveyor is fed into the crusher and then elevated and distributed by a pivoted bucket conveyor passing over the bunker. From the bunker a 2-ton weigh larry transfers the coal to the stoker hoppers. On the return side the pivoted bucket conveyor passes through a trench in the basement floor, where it receives the ash and transfers it to an overhead bunker from which it can be discharged either into railway cars or trucks. A narrow-gage industrial track with cars is used to transport the ash from the hoppers to the conveyor.

Practically all condensate and drips are returned to the feed-water heater through a receiving tank under float control. The heating system returns are withdrawn by a vacuum pump and discharged directly into the receiver. The high-pressure drips first pass through a condenser to give up their heat to the makeup water and by a vacuum pump are discharged into the receiver.

With the addition of the two new boilers it was decided to utilize the wood refuse available from the manufacturing plant as a valuable auxiliary fuel to be burned practically in suspension on top of the stoker fire. The equipment for hogging, transporting, collecting and feeding this form of fuel is an interesting feature of the plant. Its general arrangement is shown in the illustration.

In the manufacturing process considerable wood refuse is available, some as sawdust which can be transported readily to the fuel bins and some requiring hogging to reduce it to suitable condition for transporting. This material is received in cyclones over the boiler-room roof and by a scraper conveyor distributed to three bunkers, one over each of the smaller boilers and a third over one of the new boilers. Alternating spouts lead to opposing sides of each bunker to insure uniform filling and flap valves under the conveyor trough make it possible to switch from one spout to the other as desired.

PRINCIPAL EQUIPMENT IN ADDITION TO POWER HOUSE OF BUDD WHEEL COMPANY, DETROIT, MICH.

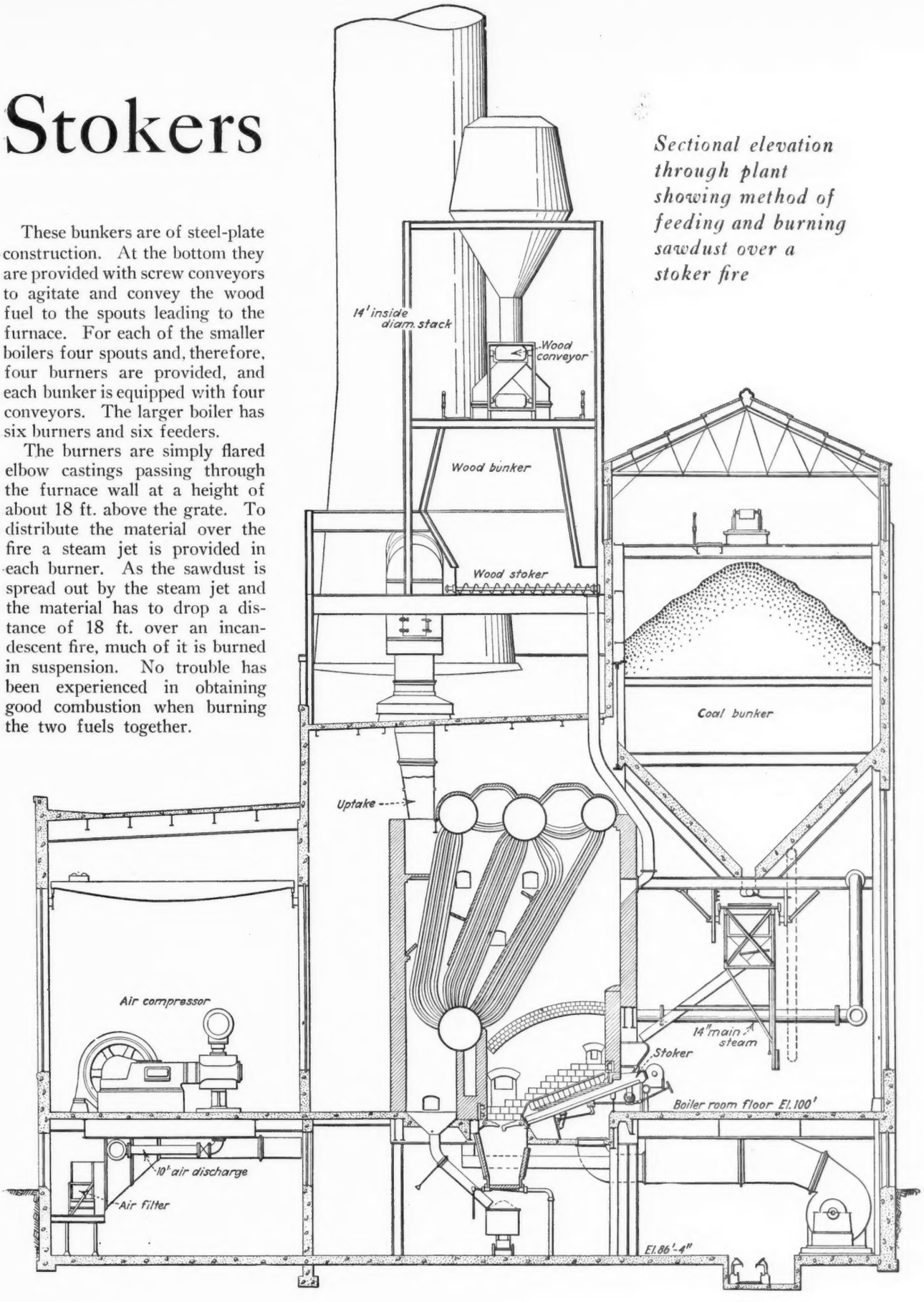
| | |
|---|---|
| Boilers, two, 12,500 sq.ft., Heine bent tube type, max. rating 375 per cent | Combustion Engineering Corp. |
| Boiler settings, single; furnace volume 4,200 cu.ft.; height of center of mud drum above floor 8 ft.; bridge wall of Detrick arch construction; in side walls three rows of Bernitz perforated blocks following line of fuel bed; in front wall and bridge wall two rows of Bernitz blocks | |
| Stokers, two, 11 retort underfeed, turbine drive, steam operated ash dumps | Westinghouse Elec. & Mfg. Co. |
| Ash hoppers, sectional cast-iron plate, two | Allen-Sherman-Hoff Co. |
| Ash gates, water collecting, eight | Allen-Sherman-Hoff Co. |
| Soot blowers | Bayer Co. |
| Fans, forced-draft, two, 78,000 c.f.m. at 5-in. stat. press | Buffalo Forge Co |
| Stack, steel, radial brick lining, 200 ft. above grate, 14 ft. diam. | Heine Chimney Co. |
| Coal and ash handling equipment, pivoted bucket conveyor and industrial cars | Stephens-Adamson Mfg. Co. |
| Sawdust-handling equipment, screw conveyors | Stephens-Adamson Mfg. Co |
| Hog for wood refuse | Mitts & Merrill |
| Heater feed water, 90,000 lb. per hr.; V-notch recording meter 150,000 lb. per hr | Cochrane Corp. |
| Standpipe, 200,000 gal | Chicago Bridge & Iron Works |
| Pump, boiler feed, 3-stage, 500 g.p.m., 500 ft. head | DeLaval Steam Turbine Co. |
| Pumps, service, two 150 g.p.m., one 200 g.p.m. | DeLaval Steam Turbine Co. |
| Air Compressors, two, 27x16x21-in., 2,500 c.f.m., inner and after coolers, 800-hp. motors | Bury Compressor Co. |
| Air filters, National rotary, two, 42x30-in., each 10,500 c.f.m. | Drying Systems, Inc. |
| Air receivers, two, 6x18-ft. | Poe Co. |
| Heater used as condenser for h.p. drips, 1,000 lb. per min. | Alberger Heater & Condenser Co. |
| Heater, domestic hot water, 35 g.p.m. from 50 to 130 deg. F. with steam at 3 lb. pressure | Alberger Heater & Condenser Co. |
| Meters steam and air flow | General Electric Co. |
| Draft gages | Lewis M. Ellison |
| Draft control | Hagen Corp. |
| Feed-water regulators | Stets Co. |

Both the original plant and the addition were designed by Albert Kahn, Inc., of Detroit, Mich.

# Stokers

These bunkers are of steel-plate construction. At the bottom they are provided with screw conveyors to agitate and convey the wood fuel to the spouts leading to the furnace. For each of the smaller boilers four spouts and, therefore, four burners are provided, and each bunker is equipped with four conveyors. The larger boiler has six burners and six feeders.

The burners are simply flared elbow castings passing through the furnace wall at a height of about 18 ft. above the grate. To distribute the material over the fire a steam jet is provided in each burner. As the sawdust is spread out by the steam jet and the material has to drop a distance of 18 ft. over an incandescent fire, much of it is burned in suspension. No trouble has been experienced in obtaining good combustion when burning the two fuels together.




*Sectional elevation through plant showing method of feeding and burning sawdust over a stoker fire*

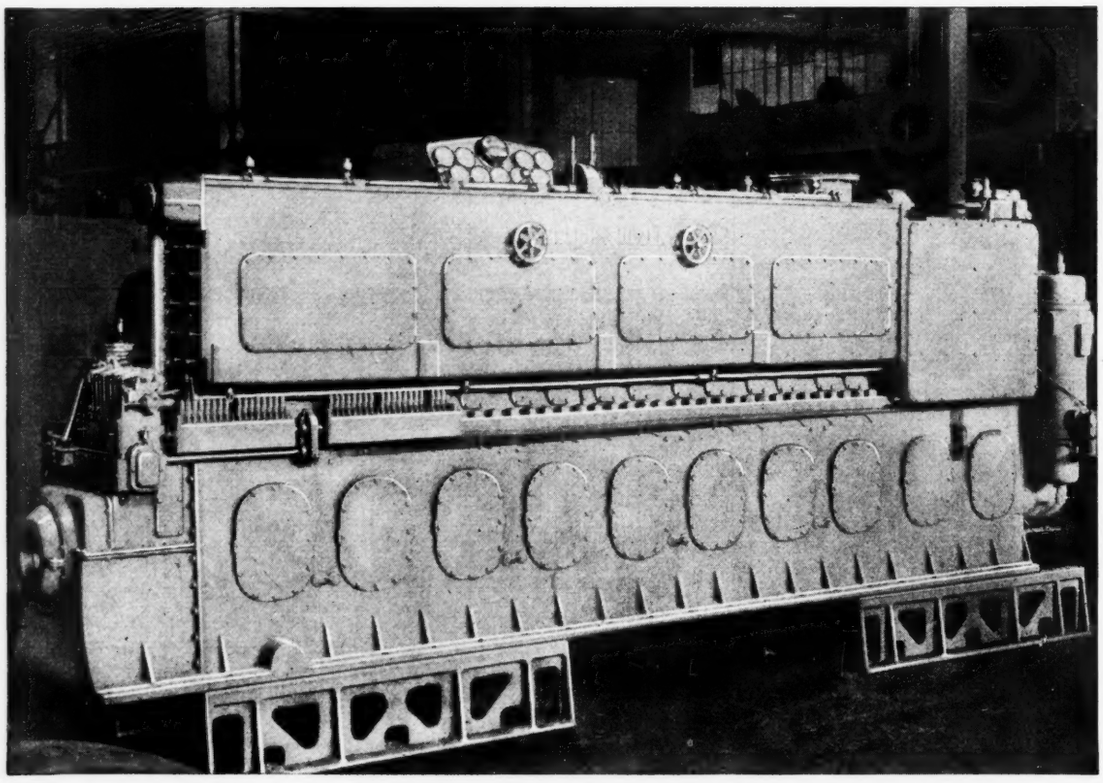


*Fig. 1—The Busch-Sulzer Bros. type E Diesel*

## *Busch-Sulzer Bros. Build*

# Large High-Speed Diesels

MORE and more engineers are coming to believe that slow speed is not an essential requirement for reciprocating engines. Builders have speeded up the rotative speeds of oil engines, but until recently this practice has applied mainly to units of small power. But the high-powered Diesel has been receiving attention and Busch-Sulzer Bros.-Diesel Engine Company announces that it has developed a light-weight high-speed design and is prepared to furnish engines up to 1,200 hp. to operate at 300 r.p.m.

For several years the Busch-Sulzer two-stroke-cycle submarine-type engine has been built up to 2,500 hp. to operate at speeds above 450 r.p.m. These units, however, are not for constant service, and, as lightness is essential, weigh as low as 55 lb. per hp. The company set about the design of an engine to run at 300 r.p.m. in 1921, and as long life and continued duty were desired, the engine was designed to weigh about twice as much as a submarine engine.

This Type E two-stroke-cycle air-injection engine is suitable for both stationary and marine service. As its floor space and headroom are small, it is especially suited for installations where space is at a premium or where a stand-by unit is needed.

The front view of an eight-cylinder 1,200-hp. unit appears in Fig. 1. The scavenging air is delivered by the twin scavenging pumps, shown at the left end of the engine, to the air manifold running along the front of the unit. The air enters the working cylinders through strip-type air valves. Similar valves are used on the scavenging pumps.

The exhaust ports connect with a water-cooled manifold placed along the rear of the engine frame.

The bedplate is a single iron casting with ample flanges, planed underneath for bolting to the foundation. The crankpit does not reach below the flanges, and the sides extending upward form a totally inclosed oiltight housing when the cylinder bloc is bolted to the heavy top flanges. Removable doors permit inspection and adjustment.

Bridges, with bored seats for the main bearing shells, add to the rigidity and form separate crankpits. The seats for the bottom shells are carefully lined up before the shells are put in. After being placed in their seats, the shells are scraped to alignment with the crank-shaft

There is but one valve per cylinder head. This permits a symmetrical casting both simple and safe. The fuel-valve driving mechanism is offset to obviate the necessity of packing around the fuel needle, insuring smooth opening and closing of the fuel valve.

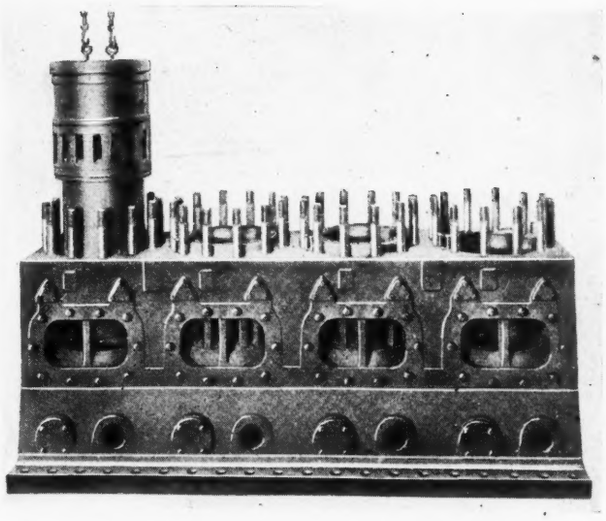


*Fig. 2—The exhaust side of the engine*

The piston and connecting rod are of standard Busch-Sulzer design. As will be seen from Fig. 3, the piston-pin bearing is a one-piece bushing.

The rear, or exhaust, side with a liner being removed is shown in Fig. 2. The liners are cast of a special hard and close-grained iron mixture. Cooling-water inlets are seen at the lower edge; the outlets are at the top.

The fuel pump, mechanical lubricator, governor and fuel-priming pump, are placed at the flywheel end. The mechanical lubricator has a separate plunger for each feed to the working and compressor cylinders, provision being made for lubrication at four points on the circumference of each working cylinder.

The fuel pump has one plunger per working cylinder. The position of the governor determines the relative time of closing of the pump-suction valves, thus regulating the amount of fuel actually delivered. Individual adjustment is obtained by thrust screws in controlling arms, and separate latches are provided to cut out individual cylinders. The driving parts of pump are readily accessible through sliding doors and a single coverplate below.

The governor is of the fully inclosed, centrifugal type, driven by a separate vertical shaft geared directly to the crankshaft. The engine speed, through the governor, fixes the position of a horizontal shaft to which a dash-pot is attached. This shaft is linked to the eccentric shaft of the pump control arms, as well as to the inlet valve of the air compressor to regulate injection air automatically to suit the load. Handwheel adjustment of governor spring tension is provided for synchronizing. For direct reversible engines the governor is not furnished, as the fuel-delivery pump is controlled by hand.

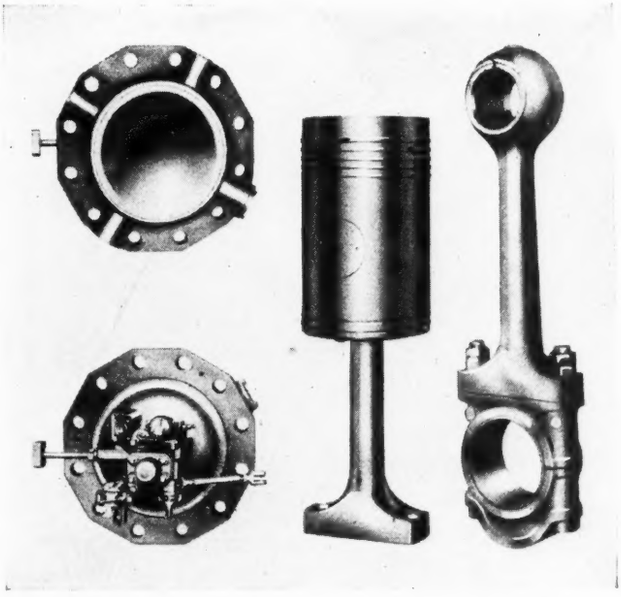


*Fig. 3—The cylinder head, piston and rod*

## ANSWERS to "What Do You Know"

*The questions are on page 138*

Ans. 1—By the term "duty" is generally meant the number of foot-pounds of work done by the pump in lifting water, per hundred or per thousand pounds of steam. For example, of 1,000,000 lb. of water pumped against 100 ft. discharge head at an expenditure of 1,000 lb. of steam, the duty is 100,000,000 ft.-lb. per 1,000 lb. of steam.

Ans. 2—It may have two purposes. A sleeve may be used to protect the shaft against corrosive liquids, or it may be applied to take the natural bearing wear.

Ans. 3—Yes, if the pump has normal impeller clearances, no heating will occur. If, however, the pump is filled with water and the discharge valve closed, continued churning of the trapped water will heat it to a dangerous point.

Ans. 4—The thrust bearing should not carry any of the rotor weight. Its only purpose is to prevent longitudinal movement and it should fit the bearing case with a small clearance so that it can creep in the direction of rotation.

Ans. 5—Yes, provided the entire pressure drop from atmospheric to 29 in. takes place in the turbine or engine, and not in the exhaust connection or in the condenser.

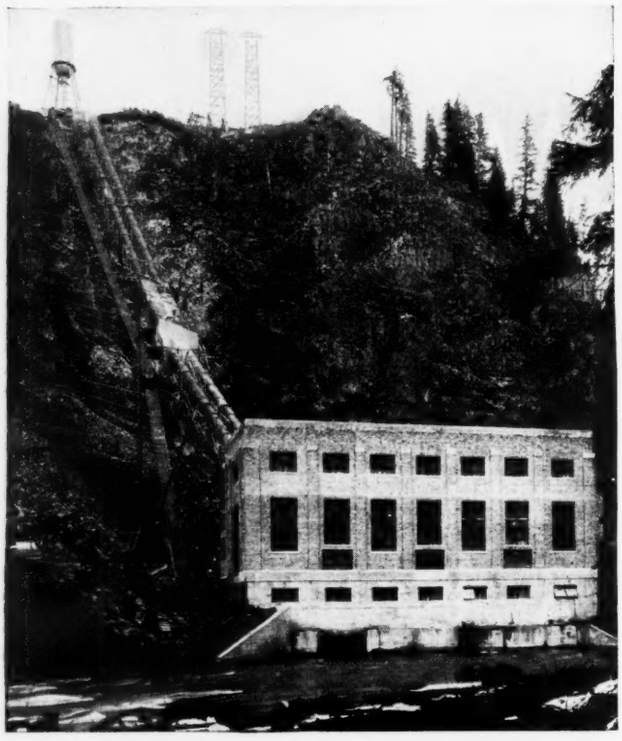
Ans. 6—The ratio of the heat converted into power to the total heat that has been added to the working fluid up to the beginning of expansion, is the thermal efficiency. For example, a horsepower-hour is equivalent to 2,545 B.t.u. If the engine uses per hour 20 lb. of steam which contains 1,100 B.t.u. per lb., measured from feed water at 180 deg. F., the thermal efficiency is $2{,}545 \div 20 \times 1{,}100 = 11.5$ per cent.

Ans. 7—The Rankine cycle is that cycle of events through which steam passes in doing work in a perfect engine. The four stages are: The feed water is raised from the temperature corresponding to the engine exhaust pressure, to the temperature of the admission steam; the water is then evaporated at a constant pressure; it is expanded in a non-conductive cylinder down to the back pressure, and finally is rejected at a constant back pressure and temperature to the condenser.

Ans. 8—The cycle consists of two constant-pressure and two isothermal lines.

Ans. 9—The air in the bottle had a pressure of 14.7 lb. per sq.in. abs.; the hot water will have a vapor pressure of approximately 8 lb. abs. The total pressure will be the sum of the two pressures, or 22.7 lb. In addition the pressure may rise above this amount by reason of the heating of the air by the water, causing the air pressure to rise above 14.7 pounds.

# Time and Cost Record *Made at New Hydro Plant*



IN 1926 the California Oregon Power Company was confronted with the necessity of providing a larger power output to insure meeting power contracts then in force and to provide for a reasonable growth in the system's load. A study of projects located on streams within the company's territory resulted in the selection of a site on the north fork of the Rogue River, where Prospect No. 1 plant of approximately 4,000 kw. capacity had been built in 1911. Two outstanding factors favoring this decision were the uniform water supply and the low cost of the energy produced, as the investment in the project per kilowatt of capacity was held to a figure well under the average on the Pacific Coast.

It was discovered that the Rogue River had the most uniform flow of any stream in the southwestern part of Oregon. A duration curve of the stream flow for a period of seventeen years indicated sufficient water at Prospect to produce 16,000 kw. of primary power and 32,000 kw. of secondary power. Of the latter it was decided that a large part could be made primary power by diversing water from other tributaries of Rogue River.

As finally adopted, the design provides for the ultimate installation of three units of 16,000 kw. each and includes the following main features: Diversion dam, canal, forebay, pipe lines, surge tank, penstocks, power house, generating equipment, substation and transmission lines. Originally, the initial development had been planned for one generating unit, but to include diversion dam, canal, forebay and surge tank for the ultimate development. This work was authorized on Nov. 3, 1926, and was to be completed and ready for operation by Dec. 1, 1927. In the middle of May, 1927, a new contract for a large block of power made it necessary to add the second unit, penstock and flow line.

Considered from the viewpoint of excavation and concrete yardage, length of pipe line and penstock, the time assigned for doing the work may seem to be ample. But, when it is remembered that the site is in a country composed of volcanic materials, the surface being principally pumice and clay, where concreting materials are difficult to find; that the elevation is 2,500 ft. above sea level; that all materials and machinery had to be trucked 45 miles over a mountain road; that when the work was authorized no detail drawings had been made and no contracts for equipment had been placed; and that the rainy season was on—then the time allowed was indeed short. Notwithstanding these numerous difficulties and the use of special methods of construction, the work was finished on schedule time and, as previously stated, at a cost considerably below the average. The accompanying photographs bring out the main features of the project, and the map the general arrangement of the development.

As indicated in one of these photographs, the diversion dam is a concrete structure of the gravity type, 230 ft.

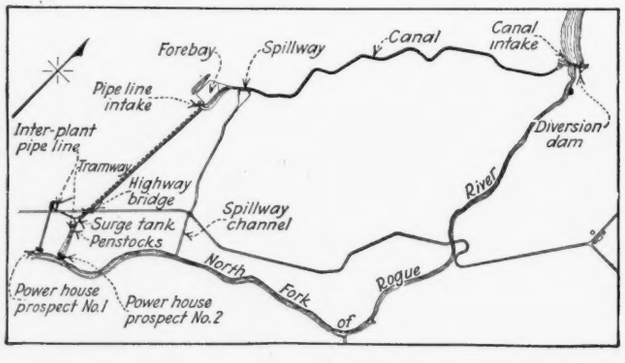



*Fig. 1—Map of Prospect No. 2 development*

long and 35 ft. maximum height, with short earth embankments at the ends. The crest is equipped with three 34x12.5-ft. tainter gates operated by worm-gear drum hoists with fixed motors and arranged for remote control. The dam is also equipped with two 4x6-ft. sluice gates operated by screw hoists with fixed motors, arranged to be interlocked electrically with the headgates of the canal, so that they will open as the canal gates close and thus regulate the discharge at the dam during normal stream conditions. A log sluice controlled by a

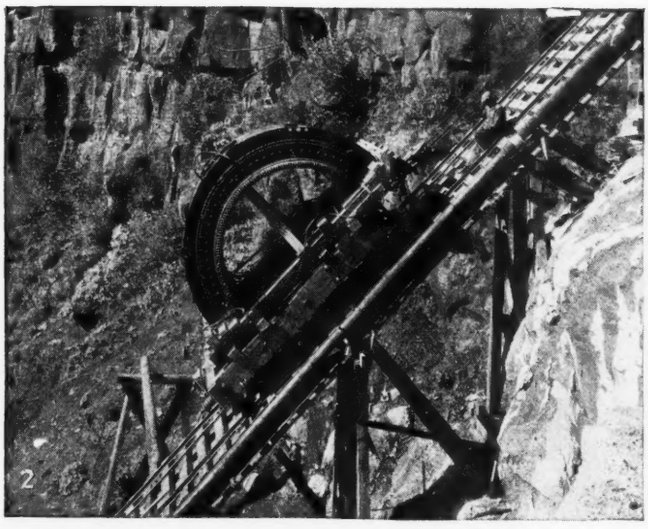


*Fig. 2—Transporting half a generator up incline to plant*

*Fig. 3—Concrete supports for the wood-stave pipe lines*

*Fig. 4—Surge tank on tower over junction of pipe lines and penstocks*

## *Constructing a High-Head Hydro Plant*

*Fig. 5—Two of the generating units installed, with space for a third*

*Fig. 6—Canal leading from diversion dam to forebay*

*Fig. 7—Completed forebay, with canal outlet in foreground*

slide gate that opens by lowering furnishes a convenient means of flushing drift out of the reservoir with a minimum loss of water.

One of the photographs shows the canal leading from the intake at the dam to the forebay. This canal has a length of 7,000 ft. and throughout is lined with concrete 6 in. thick. The canal has a bottom width of 9.6 ft., side slopes of 1 to 1, total depth of lined prism of 9 ft., and a water depth for maximum capacity of 8 ft. It is so located that the water prism is in excavation.

The canal terminates in a forebay, measuring approximately 400x400 ft., which was formed by building earth

PRINCIPAL EQUIPMENT OF PROSPECT NO. 2 PLANT

| | |
|---|---|
| Tainter gates and sluice gates | Pacific Coast Engineering Co. |
| Gate hoists | D. J. Murray Mfg. Co. |
| Wood-stave pipe | Redwood Mfg. Co. |
| Surge tank and appurtenances | Western Pipe & Steel Co. |
| Large gate valves | Chapman Valve Co. |
| Penstocks | Puget Sound Machinery Depot |
| Hydraulic turbines and butterfly valves | Pelton Water Wheel Co. |
| Electric generators, 6,600-v., 3 ph., 60-cycle | General Electric Co. |
| Power house 60-ton crane and tram hoist | Cleveland Crane & Eng. Co. |
| Transformers | Westinghouse Elec. & Mfg. Co. |
| Oil switches | Pacific Electric Co. |
| Disconnecting switches | Delta Star Electric Co. |
| Switchboard | General Electric Co. |

embankments on three sides. Opposite the canal inlet is the concrete headwork of the pipe lines, which is arranged for three pipes with each opening controlled by a steel sluice gate, 9x11.5 ft., operated by motor-driven screw hoists and protected by trash racks.

From the forebay to the surge tank the water is conducted through continuous-stave redwood pipes with copper-bearing-steel bands. These pipes have an internal diameter of 87 in., are straight in alignment and have seven curves in profile, the lower one of which was made necessary on account of having to pass under the Crater Lake highway. Throughout their 3,100 ft. of length the wood-stave pipes are carried on reinforced concrete cradles spaced on ten-foot centers.

Under the surge tank these pipes connect directly with the penstocks to form an independent waterway from the forebay to the turbine of each unit. At the junction point between pipe and penstock each pipe is connected to the surge tank through a cross receiver or header and a riser pipe. In the connection between each penstock and the cross receiver is a 54-in. gate valve, making isolation for repairs or other purposes readily possible.

These penstocks vary in diameter from 87 in. at the surge tank to 72 in. at the butterfly valve, located at the intake of the turbine casing, and in thickness of metal from $\frac{3}{8}$ to $\frac{15}{16}$ in., respectively. All work is riveted except the sections forming the slip joints, and these are forge welded. Supported on concrete saddles, the penstocks are held in place by concrete anchors at each angle, with slip joints in each run between anchors.

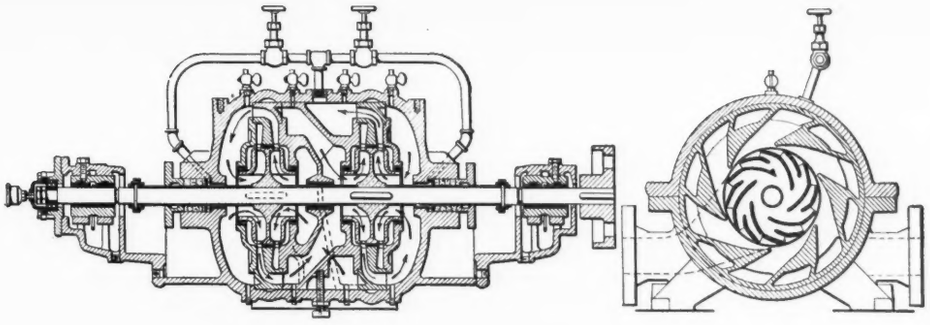
Except for certain parts of the substructure that cannot be completed until the third turbine is in place, the power house has been built for three generating units. It has a concrete substructure, with the draft tubes formed in the concrete, and a brick and steel superstructure. In the present installation of two units the prime movers are Pelton-Francis turbines rated at 23,400 b.hp. when operating at 514 r.p.m. under 590 ft. head. These machines are equipped with Pelton governors and governor-operated bypasses, or pressure regulators, with a capacity of 75 per cent of the turbine discharge at full load. Each turbine drives a 6,600-volt three-phase 60-cycle alternator, rated at 20,000 kva., or 16,000 kw. at 80 per cent power factor. The exciters are mounted on top of the generators.

Auxiliary electrical equipment consists of two banks of three single-phase 6,600—73,800-volt transformers located outside the power house on the uphill side. Each bank of transformers is directly connected to its generator without a station bus or switching equipment.

On top of the elevation near the surge tank, about 1,500 ft. from the power house, is the switching station, in which steel construction was used throughout. Provision is made for three outgoing lines with suitable switching equipment, for which the control is at the power-house switchboard. Here also are the water level indicators with controls for all the principal valves and hydraulic gates.

The plant was designed and constructed by the Byllesby Engineering and Management Corporation, of Chicago, of which H. W. Fuller is vice-president in charge of engineering and construction; F. H. Lane, manager of engineering and construction; J. William Link, hydraulic engineer; A. H. Tracy, electrical engineer, and George F. Phythian, superintendent of construction.

*Fig. 8—Downstream side of completed dam*



# *What* AIR LEAKAGE *Does to a Centrifugal Pump*

By Robert W. Angus
*Professor of Mechanical Engineering*
AND
C. V. Armour
*Demonstrator in Hydraulics*
*University of Toronto*

ENGINEERS using centrifugal pumps are well aware of the serious effect of an air leak on the suction side of the unit. Figures are, however, lacking to connect the volume of air leaking in with the decrease in capacity and efficiency, and it was for the purpose of getting such information that the investigation described here was made.

The experiments were made in the Hydraulic Laboratory of the Department of Mechanical Engineering, University of Toronto, and of the several pumps in the laboratory the most convenient one for the purpose was a 3-in. four-stage Rees pump made and presented by Goldie & McCullough, Galt, Ontario. This pump was selected purely because of the convenience with which it could be experimented on. It is direct connected to an electric motor. To the 3-in. horizontal suction branch of this pump there was attached a nipple 6½ in. long screwed into the companion flange bolted to the suction branch and also screwed into a 3-in. long-radius elbow from which a vertical 3-in. pipe, 5 ft. 6 in. long, extended down to the well.

Ordinarily, this suction pipe has a foot valve for convenience in priming, but the resistance of such valves varies, and to prevent its effect from vitiating the points under examination, the foot valve was removed and the water, therefore, entered the open end of the 3-in. suction pipe direct, in all the experiments. The discharge of the pump was also 3-in. and carried the water to a calibrated measuring tank. A valve in the discharge pipe enabled the discharge to be controlled.

The suction and discharge pressures were taken on gages tapped into the suction and discharge flanges, both of which were at the same level. The air admitted in the course of the experiments entered through a ¼-in. pipe tapped into the side of the suction flange, and by tightening the glands and smearing them and all suction pressure joints with vaseline, it is believed that air could not enter the pump in any other way than through this ¼-in. opening. The suction inlet was always so far below the water surface that direct entry of air through the bottom of the suction pipe was impossible.

A considerable problem presented itself in the regulation and measurement of the air admitted. For two months work was conducted with a large displacement gas meter for measuring the air, and by means of a cock between the meter and suction pipe the flow of air was regulated. This had two objections, the first being the pulsations in flow caused by the movement of the meter bellows, and the second and more serious difficulty that the rate of flow could not be predetermined and, therefore, it was almost impossible to admit any specified volume of air per second, and it was

**Everybody who uses centrifugal pumps—and what engineer doesn't?—knows that air must be kept out of the suction connections, but few know just how much damage a little air leak does. Here is a splendid bit of actual evidence. To be sure, it applies to only one pump, but probably much the same sort of thing would be found for any pump.**
**Keep your pump suction air tight.**

also impossible to keep the rate of flow constant for different experiments. After nearly two months' work the method was abandoned.

It was then decided to use a thin plate orifice in a pipe line. The measuring tube was 1½-in. pipe about 5 ft. 4½ in. long, the orifice was placed 2 ft. 3 in. from the place where the air entered the 1½-in. pipe, and the pipe was continued over 3 ft. below the orifice before it was reduced to ¼ in. for connection to the pump suction. The differential gage across the orifice was connected to two ¼-in. pressure taps, one 3½ in. above the orifice and the other 12 in. below the orifice, care being taken that the pressure taps came flush with the inside of the pipe. Only two sizes of orifice were used, ¼-in. and ½-in., the differential being controlled by the small cock placed between the 1½-in. pipe and the point of connection to the suction pipe of the pump.

The volume of air passing through the orifice was calculated from the formula ordinarily used with such a device

$$Q = A_2 v_2 = \frac{A_2 c\sqrt{2gH}}{\sqrt{1 - \left(\frac{A_2}{A_1}\right)^2}}$$

where $Q$ is the discharge in cubic feet per second, $A_1$ and $A_2$ are the areas in square feet of the pipe and of the orifice respectively, $H$ is the differential head in feet of air column and $c$ is a coefficient. No allowance was made for the expansion of the air after passing the orifice, and the approximate value of the coefficient $c$ was taken as 0.62 throughout. This introduced some error, but it was very slight and the method of conducting the experiments was such as to minimize it.

An examination of the curves shows the method of procedure. The speed was kept constant at 1,700 r.p.m. and the first test was run with no air admitted to the suction and the glands and all joints closed with vaseline, as already described, which gave the curves $A$. The curves $B$ were then made by fixing on a definite differential on the orifice and adjusting the cock between it and the suction pipe to give the same differential at each discharge. The other curves $C$, $D$, $E$, $F$, $G$, were obtained similarly.

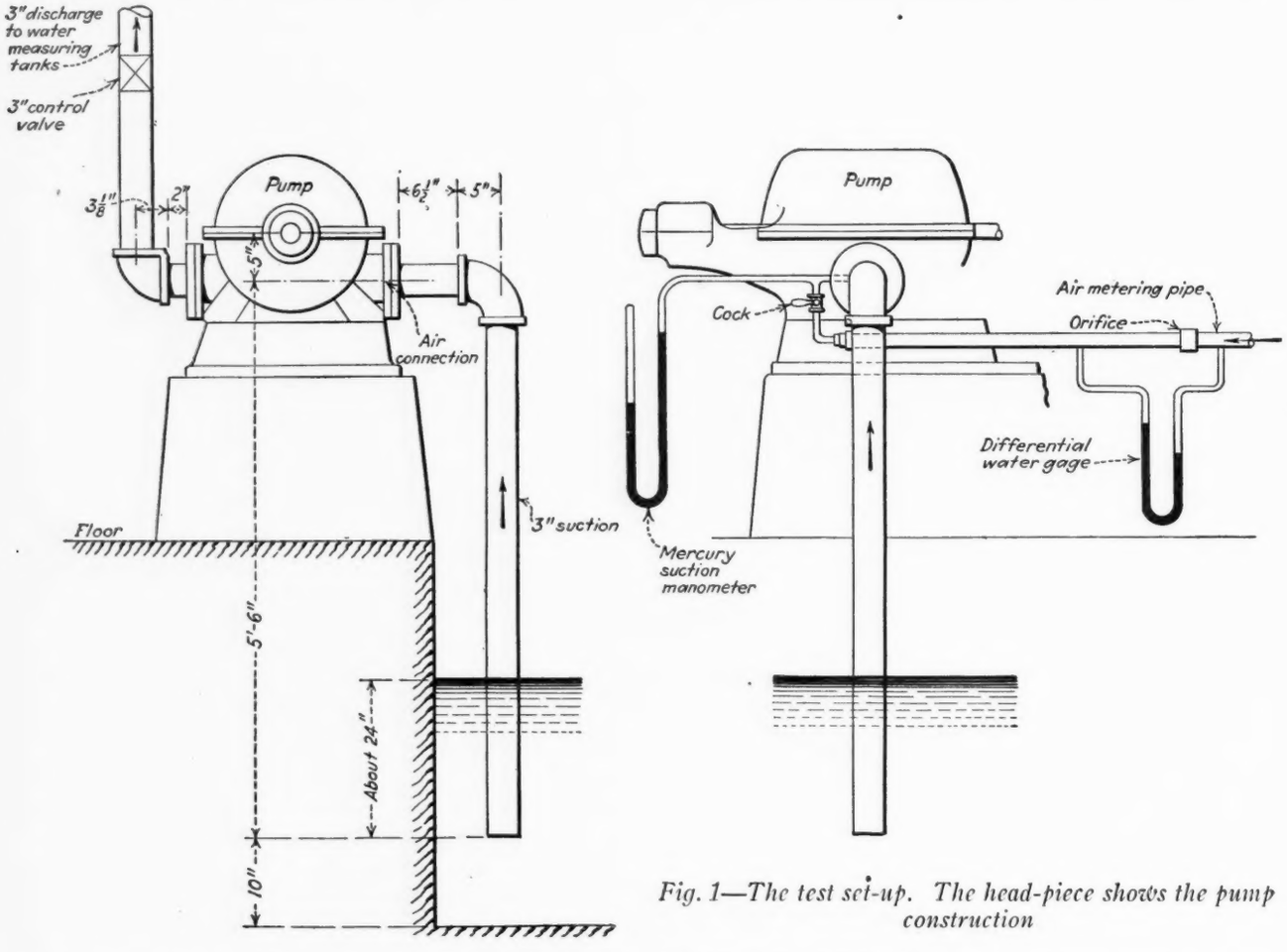



*Fig. 1—The test set-up. The head-piece shows the pump construction*

Throughout the work measurements were taken to determine the efficiency and the head discharge curves.

The two sets of curves show in a marked way how objectionable air is in the suction pipe. For each curve many more points were obtained than are shown in the figures. For greater convenience in comparing the effects of the air the accompanying table has been constructed, where for eight heads the results have been taken from the curves. This table is self-explanatory, but it is to be noted that the air admitted is computed under atmospheric conditions, whereas the volume entering the suction pipe is greater owing to the suction lift. Full data are given for those desiring to determine the results on this basis.

In the table all percentages are given in terms of the volume of water discharged at the given pressure when no air is admitted to the suction pipe. Apparently, there is no relation between the percentage of air admitted and the percentage reduction in discharge, but for the larger volumes of air the percentage decrease in dis-

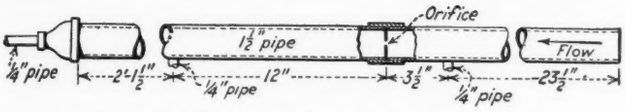



*Fig. 2—The air orifice and pressure taps*

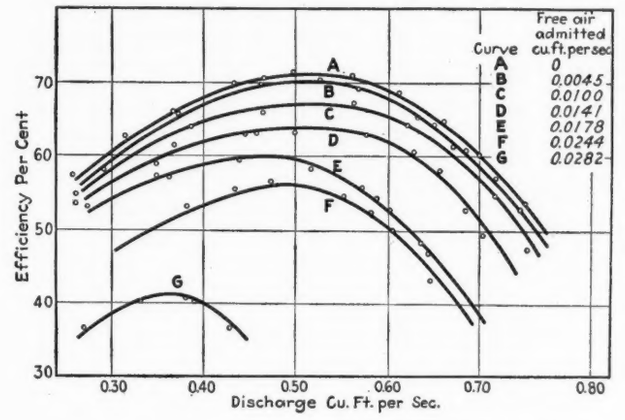



*Fig. 3—Air leakage reduces pump efficiency*

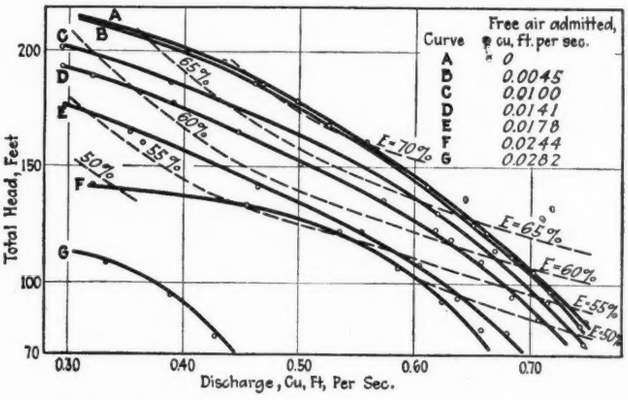



*Fig. 4—Head-discharge curves show serious effects of air leakage*

The dotted lines are lines of constant efficiency.

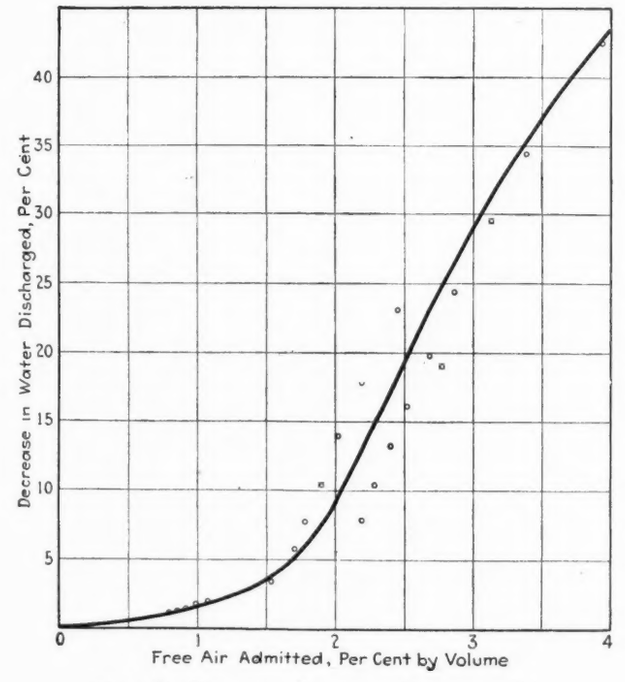



*Fig. 5—Decrease in water discharge for varying air leakage*

charge was approximately ten times the percentage of air present, and this ratio falls to about unity with the smaller percentages of air. The percentage of loss in discharge has been plotted against percentage of free air admitted in Fig. 5, and the curve is a fairly definite one, although possibly it might be fairer to draw two limiting curves.

The curve in Fig. 5 shows in a striking way the effect of the air. Up to about 1.5 per cent the loss in the pump is slight, but beyond that the curve rises steeply almost in a straight line, and for 4 per cent air leakage the discharge loss is over 40 per cent. In practice the leakage of air occurs largely at the glands and flanges and is directly dependent on the suction lift; if the pump

EFFECT OF AIR LEAKING INTO THE SUCTION PIPE OF A CENTRIFUGAL PUMP

| Suction Lift, Ft. | Total Head, Ft. | Discharge No Air Admitted, C.F.S. | Free Air Admitted, C.F.S. | Water Discharged, Air Admitted, C.F.S. | Free Air Admitted, Per Cent | Loss of Discharge, Per Cent |
|---|---|---|---|---|---|---|
| 5.65 | 200 | 0.408 | 0.0100 | 0.314 | 2.45 | 23.02 |
| 6.50 | 200 | 0.408 | 0.0045 | 0.400 | 1.09 | 1.96 |
| 6.20 | 190 | 0.454 | 0.0141 | 0.320 | 3.12 | 29.50 |
| 6.40 | 190 | 0.454 | 0.0100 | 0.374 | 2.20 | 17.60 |
| 7.15 | 190 | 0.454 | 0.0045 | 0.446 | 0.99 | 1.76 |
| 6.20 | 180 | 0.493 | 0.0141 | 0.373 | 2.87 | 24.35 |
| 7.10 | 180 | 0.493 | 0.0100 | 0.424 | 2.02 | 14.00 |
| 7.75 | 180 | 0.493 | 0.0045 | 0.486 | 0.91 | 1.42 |
| 5.05 | 170 | 0.527 | 0.0178 | 0.334 | 3.39 | 36.65 |
| 6.90 | 170 | 0.527 | 0.0141 | 0.422 | 2.68 | 19.93 |
| 7.80 | 170 | 0.527 | 0.0100 | 0.472 | 1.90 | 10.45 |
| 8.40 | 170 | 0.527 | 0.0045 | 0.520 | 0.85 | 1.33 |
| 5.85 | 160 | 0.560 | 0.0178 | 0.383 | 3.18 | 31.60 |
| 7.55 | 160 | 0.560 | 0.0141 | 0.470 | 2.52 | 16.08 |
| 8.45 | 160 | 0.560 | 0.0100 | 0.516 | 1.78 | 7.86 |
| 9.05 | 160 | 0.560 | 0.0045 | 0.554 | 0.80 | 1.07 |
| 6.70 | 150 | 0.589 | 0.0178 | 0.430 | 3.03 | 26.95 |
| 8.25 | 150 | 0.589 | 0.0141 | 0.512 | 2.40 | 13.08 |
| 9.10 | 150 | 0.589 | 0.0100 | 0.555 | 1.70 | 5.77 |
| 9.60 | 150 | 0.589 | 0.0045 | 0.584 | 0.76 | 0.85 |
| 6.75 | 140 | 0.616 | 0.0244 | 0.352 | 3.96 | 42.80 |
| 7.40 | 140 | 0.616 | 0.0178 | 0.477 | 2.89 | 22.58 |
| 8.95 | 140 | 0.616 | 0.0141 | 0.553 | 2.29 | 10.22 |
| 9.70 | 140 | 0.616 | 0.0100 | 0.590 | 1.62 | 4.25 |
| 10.18 | 140 | 0.616 | 0.0045 | 0.611 | 0.72 | 0.81 |
| 7.50 | 130 | 0.642 | 0.0244 | 0.483 | 3.81 | 24.78 |
| 8.05 | 130 | 0.642 | 0.0178 | 0.520 | 2.78 | 19.00 |
| 9.60 | 130 | 0.642 | 0.0141 | 0.590 | 2.20 | 7.95 |
| 10.30 | 130 | 0.642 | 0.0100 | 0.620 | 1.55 | 3.43 |
| 10.75 | 130 | 0.642 | 0.0045 | 0.638 | 0.70 | 0.62 |

is submerged, the lift is zero and there is no air leakage. As the pump is raised above the suction well, the suction lift is increased, more particularly where the velocity in the suction pipe is high, and the air leakage is greatly augmented, resulting in the serious losses indicated. For example, if the suction velocity is 8 ft. per sec., then a pump placed at the suction level will have a net pressure of one foot of water, causing air leakage, but if it is raised 8 ft. above the suction well, the net head causing air leakage will be 9 ft. and the volume of free air leakage would be three times as much as in the former case.

Centrifugal pumps of other types may give somewhat different results, but the experiments bring the information forward in a marked way.

## The Toll of Coal

*Coal costs money. It also has its price in human life. For every million tons of coal mined during 1927, 3.73 men were killed, showing a slight improvement over 3.83 men per million tons, the figure for 1926. The 1927 figure is equivalent to a human life for every 268,000 tons of coal mined.*

## Have You Ever Applied Paper and Pencil to

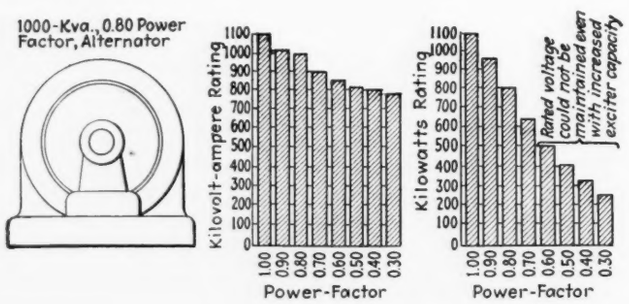
# *Your Power-Factor Problem?*

### If you have not, try it. The results may be surprising, as this article will show

By F. W. Hotchkiss
*Engineer, Electric Machinery Manufacturing Company*

LOW power factor is caused by inductive apparatus; that is, devices that require exciting current. These include induction motors, transformers, electromagnets, reactors, arc furnaces and some types of electric welders. By far the most important cause of low power factor is the induction motor, and it is because of this that the power factors of practically all industrial circuits are low.

Poor power factor, owing to the circulating exciting current of inductive apparatus, results in a number of disadvantages, such as:




| Power factor | 1.00 | 0.90 | 0.80 | 0.70 | 0.60 | 0.50 | 0.40 |
|---|---|---|---|---|---|---|---|
| Kilowatts output | 1,100 | 970 | 800 | 620 | 500 | 400 | 320 |
| Investment per kw., dollars | 6.15 | 7.00 | 8.50 | 10.70 | 13.50 | 16.90 | 21.00 |
| Cost per kw. per year at 15 per cent | 0.90 | 1.05 | 1.28 | 1.61 | 2.03 | 2.54 | 3.15 |
| Efficiency, per cent | 95 | 94 | 93 | 91 | 88 | 84 | 78 |

*Fig. 1—Alternator's costs, ratings and efficiency at various power factors*

[1]Horizontal-engine driven alternator rated at 1,000 kva. 0.80 power factor, 2,400 volts, three phase, 60 cycles at 150 r.p.m. The ratings of the machine are based on the actual heating of the windings. For this reason the capacity does not vary directly as the power factor, as it is frequently assumed to do.

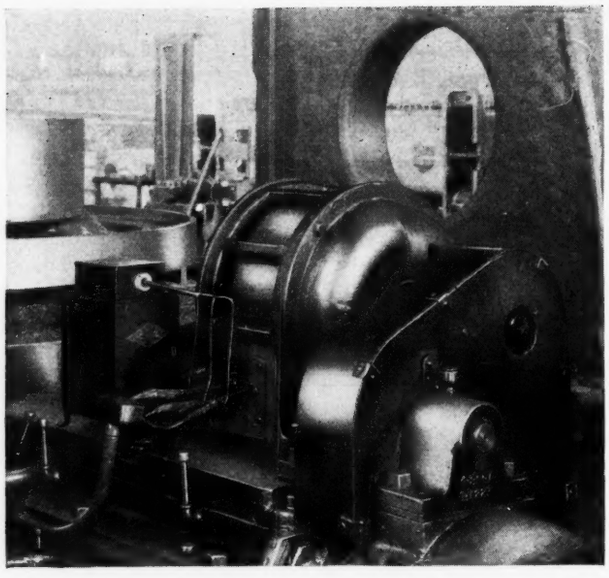


*Fig. 2—One-kva. 220-volt condenser for power-factor correction, connected to to a 15-hp. induction motor driving a boring mill*

1. Poor voltage regulation, causing a decrease in quality and quantity of manufactured products.
2. Higher energy losses.
3. Higher investment in electrical equipment, as indicated in Fig. 1.

The effects of low power factor on the generators are very marked. They are decreased kilowatt capacity, decreased efficiency and impaired regulation.

Generators are rated in kilovolt-amperes, usually at 0.80 or 0.90 power factor. The full-load kilowatt capacity is, then, respectively 80 or 90 per cent of the rated kilovolt-amperes provided the rated power factor is maintained. Thus a 1,000-kva. 80 per cent power factor alternator will deliver its rated load of 800 kw. if a power factor of 0.80 or higher is maintained. If, however, the power factor is reduced, the armature windings of the generator must carry an increased reactive current, which reduces the useful kilowatt capacity of the machine.

The increase in investment in generators at low power factor is evident from the reduction of capacity, which amounts to an increased fixed charge per kilowatt output. In anticipation of low power factor most central-station generating units are installed with a view to operation at 0.80 to 0.85 power factor, and the demand charge for electrical service is based on this power factor. Maintenance, then, of at least this power factor at the generator terminals becomes a matter of importance, since a lower power factor results in lower efficiency and higher fixed charge per unit of generating capacity both on the steam and electrical end.

Transformers are also rated in kilovolt-amperes, and their output is limited by their current-carrying capacity. The kilowatt capacity of transformers depends directly on the power factor; in other words, at 0.60 power factor the kilowatt rating of a transformer is 60 per cent of its rating at 1.00 power factor. So that with a plant power factor of 0.60, 40 per cent of the transformer investment is idle. (See Fig. 4.) This figure also shows the effects on the cost of operation and on voltage regulation.

Poor voltage regulation at low power factors often necessitates tap changing on transformers or the applica-

tion of voltage-regulation apparatus. Where transformers are overloaded, it will usually be found that this condition can be remedied by power factor improvement.

The effect of low power factor on the transmission and distribution system is threefold: It reduces the kilowatt-load capacity of the conductors or requires increased copper to carry the load; it increases the energy loss per unit kilowatt load; it causes increased voltage drop or poor regulation.

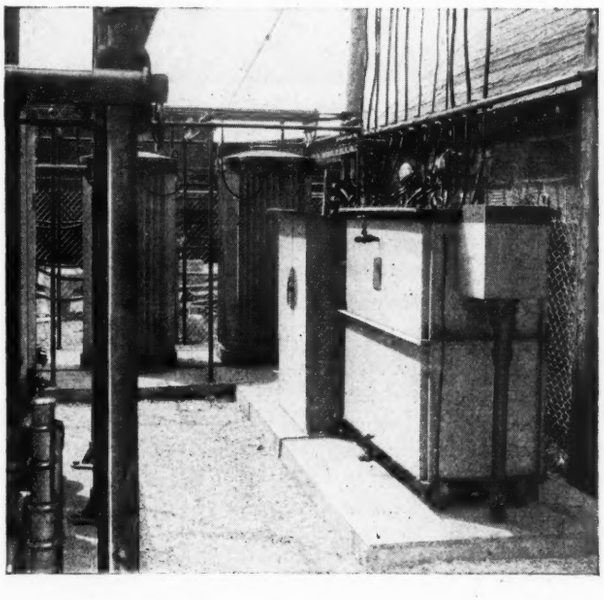
An example will serve to show the loss in capacity and the increase in losses with low power factor. Assume a 2,300-volt three-phase 60-cycle transmission line to deliver 200 kw. over a circuit one mile long, with an allowable energy loss of 5 per cent. At 0.95 power factor copper of 50,000-circ.mil section may be used, weighing approximately 2,600 lb. With copper at 20c. per lb. this line would cost $525. At 0.60 power factor, copper of 132,000-circ.mil section would be required, weighing 6,500 lb. and costing $1,300. If the 50,000-circ.mil line were used with the load at 0.60 power factor, the line loss would be increased to 12.5 per cent. The effects of power factor on a 100-kw. 440-volt line is shown in Fig. 5.

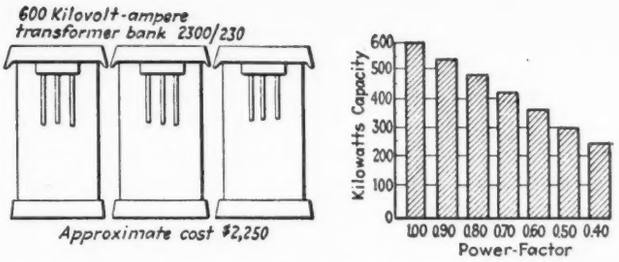
The current that a wire can carry is limited by the heating of the wire and the voltage drop through the circuit. Cables in conduit and underground cables are especially limited as to permissible heating, since the ventilation is limited. The effect of voltage drop manifests itself by decrease in torque and speed characteristics of induction motors connected to the circuit.

In plants with increasing load, therefore, more copper must be added to existing circuits or the exciting current must be reduced by improving power factor. The latter is usually more desirable, not only because of the saving in copper, but because of the beneficial effects upon the rest of the circuit back to the generator.

Good voltage regulation is a prime factor in many industries which require constant speed of the driving motors to insure uniformity of product. The tendency of poor power factor is to impair voltage regulation and thus to produce low and fluctuating voltage, which affects the speed and torque characteristics of induction motors connected to the circuit.

*Fig. 3—One 185-kva. 2,300-volt three-phase 60-cycle static condenser installed on the power distribution lines of a glass plant*






| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Power factor | 1.00 | 0.90 | 0.80 | 0.70 | 0.60 | 0.50 | 0.40 |
| Kilowatts capacity | 600 | 540 | 480 | 420 | 360 | 300 | 240 |
| Investment per kw., dollars | 3.75 | 4.18 | 4.70 | 5.40 | 6.25 | 7.50 | 9.40 |
| Cost of operation per year, dollars[1] | 610 | 610 | 610 | 610 | 610 | 610 | 610 |
| Cost of operation per year per kw. | 1.01 | 1.13 | 1.27 | 1.45 | 1.70 | 2.03 | 2.53 |
| Regulation, per cent | 1.5 | 2.5 | 3.5 | 4.5 | 5.5 | 7.7 | 8.5 |

*Fig. 4—Transformer rating, cost and regulation at various power factors*

[1]The cost of operation means the cost of the power losses in the transformers taken on a basis of full-load kva. for 3,000 hours per year. The efficiency of the transformers is taken at 98.3 per cent and the power costs at two cents per kilowatt-hour.

The starting torque and pull-out torque of an induction motor varies as the square of the voltage. The speed is also affected by the voltage. The result of low voltage on an induction motor, then, is to increase the time required for the motor to come up to speed, to increase the liability of stalling at overload or even at full load, and to cause overheating of the motor at full load. All these factors have an adverse influence on production.

In considering savings resulting from improved power factor, it is necessary to determine if power is purchased or generated, and, if purchased, the nature of the rate of the utility company with respect to power factor.

When a power user improves power factor, the central stations save at the coal pile because of decreased generator, transformer and transmission line losses resulting from circulating less exciting current. They save also in fixed costs by decreasing the investment, principally in the electrical equipment.

The reduction in power bills can be accurately anticipated. All that is required is a knowledge of the power rate schedule and some test data. Of course, if corrective equipment is installed near the point where the alternating exciting current is required, there will be an additional saving in distribution losses in the power user's plant and an improvement in voltage regulation. The last two benefits, while real, do not impress the plant owner or manager as does the more evident saving in monthly power bill. Fortunately, the lower power rate, alone, often justifies the necessary investment in corrective equipment. How low power factor may increase purchased power costs is shown in Fig. 8. With the conditions outlined under the figure the monthly power cost at 0.85 power factor is about $1,250. At 0.60 power factor the monthly bill would be about $1,460, a difference of $210, or $2,500 a year.

In general, if the central station companies, with a supposed intimate knowledge of power generation and distribution costs, offer a lower power rate for high power factor, the private plant operator likewise can realize a substantial saving. Rate savings resulting from power-factor improvement vary widely. In many instances they amount to from 8 to 15 per cent of the total bill.

Take the case of an isolated plant of 500-kw. capacity, the generator driving turbine running condensing. Assume the plant to operate ten hours a day with a load

factor of 50 per cent; that is, with an average output of 250 kw. throughout the ten hours. With coal costing $6.50 a ton and the plant operating condensing, the power costs will be over 5 per cent higher at 0.70 power factor than at 0.95 power factor.

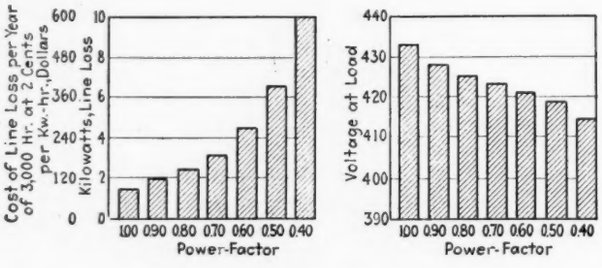



*Fig. 5—Line loss and voltage drop in distribution circuit at various power factors with a constant load of 100 kilowatts*

The circuit is for 440 volts three phase, is 400 ft. long and the wire size is No. 00, spaced six-inch centers.

In actual practice, with an existing plant, a saving in fixed costs is not realized until it is necessary to increase the capacity of distribution, transforming or generating equipment. Then power-factor improvement will show a good return by either postponing the need for more equipment or minimizing the investment.

Even if equipment is adequate for operation at low power factor, it may be necessary to operate an additional unit, resulting in greater energy loss. With fuel cost per kilowatt-hour established, estimates of the saving in copper loss by improving power factor can be readily determined.

Power factor may be corrected by synchronous condensers, synchronous motors or static condensers:

Synchronous condensers are not intended to drive mechanical loads. They are built for high speed to keep down their cost and their corrective effect is adjustable from zero to the full rating. On the other hand, a synchronous condenser needs lubrication and the attention required for any rotating machine and uses an appreciable amount of energy to supply its losses, although it does no mechanical work. A 60-cycle synchronous condenser will have, at full-load leading power factor, total losses of approximately 3½ per cent for the larger sizes and up to about 10 per cent for the smaller sizes. The cost installed, including exciter and control panel, ranges all the way from three to nine dollars per kilovolt ampere.

Wherever there is a suitable mechanical load, the synchronous motors designed for leading-power-factor operation are the most economical means of correction. There are a number of reasons why this is so.

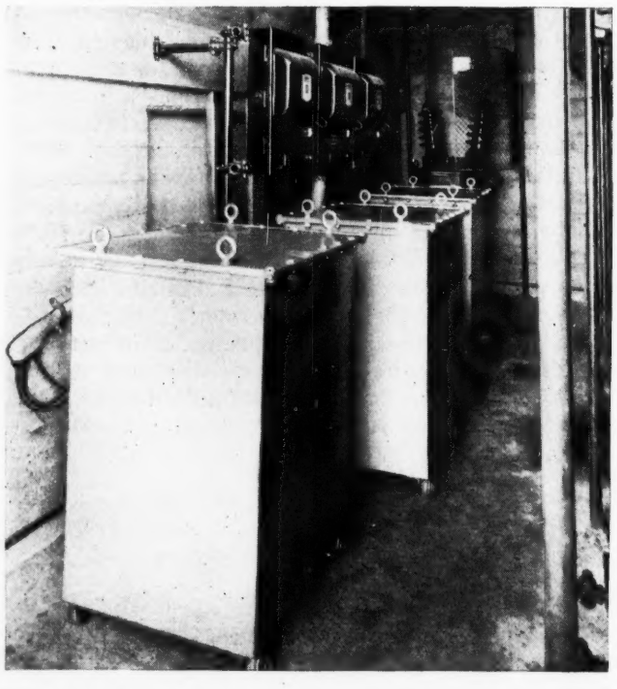
1. Materials are used most effectively because they serve the double function of delivering mechanical power and supplying correction.

2. They provide more corrective effect when carrying a certain amount of mechanical load than when the mechanical load is reduced. Thus a partly loaded synchronous motor provides more correction for a given kva. rating than a synchronous condenser equipment.

3. Medium- or low-speed 0.80 leading-power-factor synchronous motors have equal or higher efficiencies than corresponding induction motors.

4. It not only supplies correction, but also avoids the operation of an induction motor with its lagging power factor.

Severe starting-torque requirements no longer bar the use of synchronous motors provided they are of modern high-torque design. Starting torque of 200 per cent, pull-in torque of 150 per cent and pull-out torque of 300 per cent are available in medium-speed leading-power-factor synchronous motors.



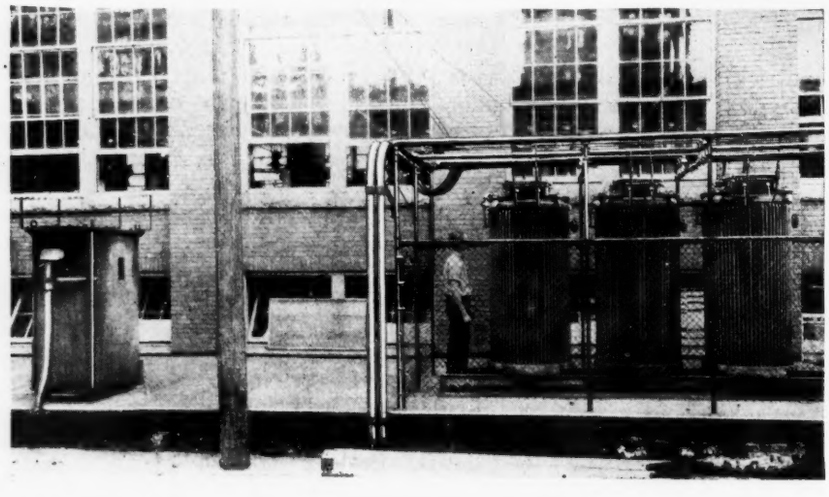


*Fig. 6 (Left)—One 220-kva. 550-volt three-phase, 60-cycle static condenser at the left of the picture, connected on the secondary side of the service transformer of a silk mill*

*Fig. 7 (Above)—One 180-kva. 440-volt three-phase 60-cycle static condenser, consisting of three 60-kva. units, each with control including a discharge reactor and an inclosed safety switch. This installation is made in a grain elevator*

Where no load is available for a synchronous motor, static condensers offer an economical means of power-factor improvement. They have no moving parts and require no attention. They require no elaborate foundation, since there is no motion or vibration. Their temperature rise under normal conditions does not exceed 20 deg. F. They occupy comparatively little space and can be installed in out-of-the-way places or outdoors. They can be installed in numerous subdivided units among the sources of low power factor.

Fig. 9 shows the relative first cost of static condensers and the part of synchronous-motor cost which is charged to correction, taken in this case as 40 per cent. It shows

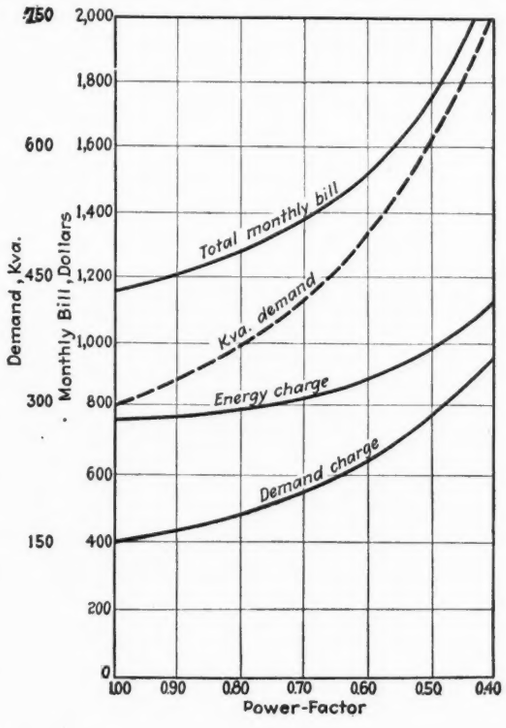



*Fig. 8—Chargers for electric power service on the basis of 0.85 power factor*

The demand charge is $1.50 per kw. at 0.85 power factor; energy charge is two cents per kilowatt-hour; maximum kilowatt demand, 300; average kilowatt demand, 200; hours use per month, 200; and kilowatt-hours per month, 40,000.

again the advantage of the synchronous motor if there is a place to use it. In the large capacities the cost for synchronous-motor correction is about one-half that for static condensers.

In Fig. 10 are shown the typical methods of installing static condensers in an industrial plant. The correction is effective only up to the point where the condenser is connected. When the condenser is connected to the high-voltage power circuit as at *A*, the power factor is corrected on the transmission line up to load side of the meter, but the transformer and the factory distribution system are not relieved of the lagging current. Connecting the condenser on the secondary side of the transformer, as at *B*, corrects the power factor of the transformer and transmission line, but does not reduce the lagging current on the factory distribution system.

A static condenser connected on a feeder supplying a group of motors as at *C*, corrects the power factor of the distribution feeder, up to the condenser, the trans-

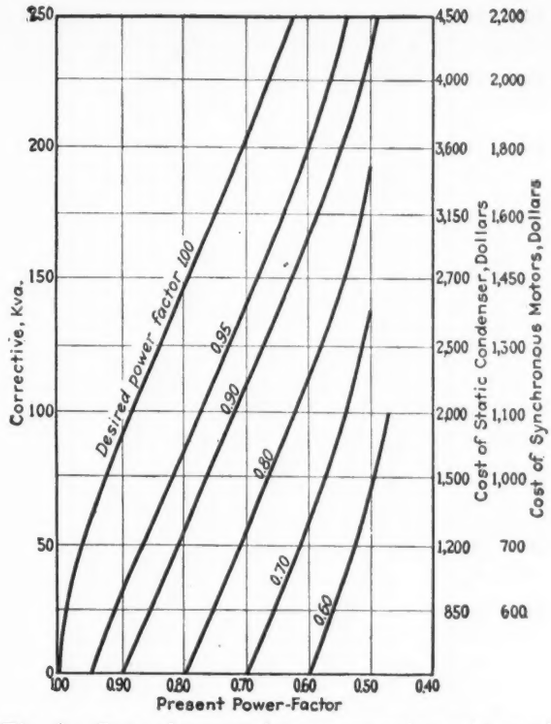



*Fig. 9—Cost of power-factor correction with static condensers and synchronous motors at 440 volts*

The figures for the synchronous motors are based on the cost of high-speed machines and charging 40 per cent of the cost of the motors and accessories to corrective kilowatt-amperes.

formers and the transmission line. When a condenser is connected to each motor, the low power factor is corrected at its source and the maximum benefit is obtained. The power system right up to the motors is relieved of the lagging current. Which system is to be used will depend upon local conditions. In Figs. 2, 3, 6 and 7 are shown typical static-condenser applications for power factor correction.

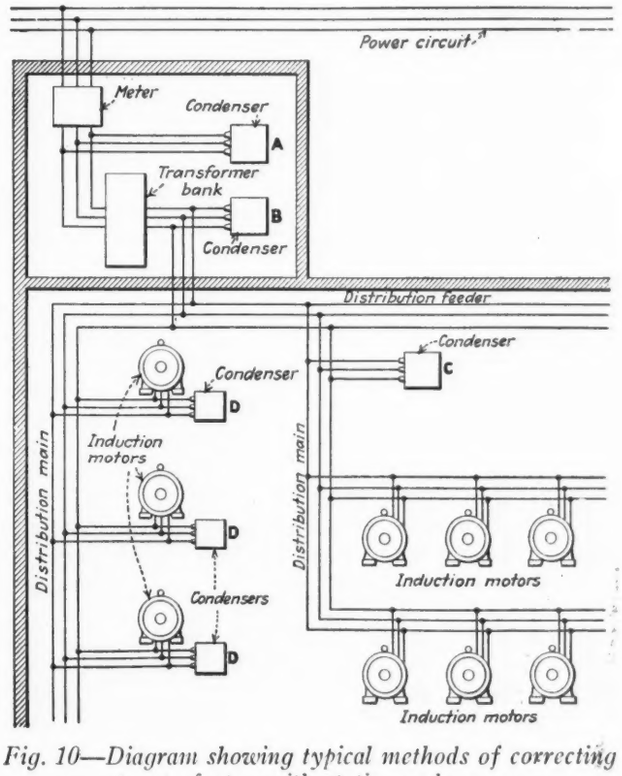



*Fig. 10—Diagram showing typical methods of correcting power factor with static condensers*

# *Right Out of the Plant*

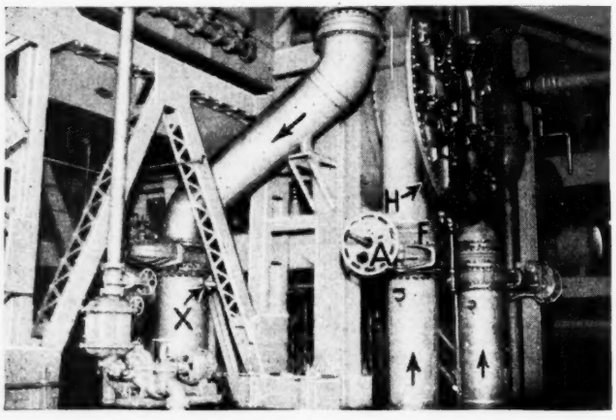
BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

## Cleaning Condensers Without Taking Them Out of Service

IN ONE of the generating units in our plant there is a 27,000-sq.ft. horizontal two-pass divided water-box surface condenser with 5,200 one-inch tubes. Circulating water is first pumped into a pressure tunnel, then up and out through the condenser to the discharge tunnel. The outlet has a 20-ft. drop and this creates a vacuum or siphonic head in the circulating-water side of the condenser; consequently, the starting head on our circulating pump is more than the head pressure after we have water going through the condenser.

With a clean condenser we have just a slight vacuum at the intake gages and a reading on the vacuum side of the outlet gages equal to 9½ ft., the gages being compound foot-head gages. Drain lines from the first-pass water-box drain into the discharge line.

We used to drain the condenser and open the doors to remove the trash, but to our surprise we noticed on a few occasions that the tube ends were perfectly clean. In checking up, we found that if we drained the water before the pressure on the intake gage (due to trash)




*Arrangement of condenser connections*

rose above 15 ft., we would get the tube ends clean and rid of trash by just draining, without opening the doors.

To remove the trash in this way, starting with the left half of the condenser, we close the air offtake to the jets from the left half, close inlet valve *A*, open drain valve *F*, remove the plug *H*, which is a vent, allow this half to drain about five minutes, then replace plug *H*, close the drain valve *F*, open valve *A*, and the air offtake valve. When this half of the condenser is again in service, we proceed in the same manner with the right half.

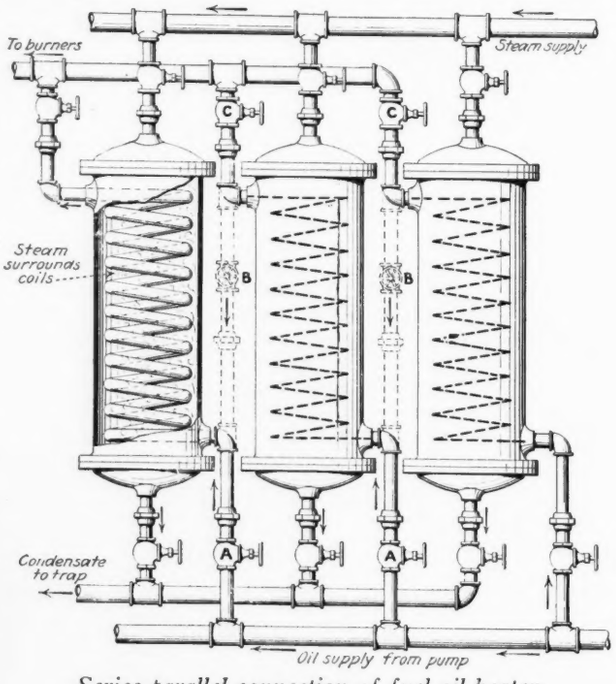
After we have cleaned both sides, we again close the inlet valve on the side we first cleaned, so as to be sure that we get rid of all the air on the water side. We go through this procedure with a load of 11,000 kw. on the unit.

GEORGE LUDWIG.

Springfield, Ohio.

## Changing the Fuel-Oil Heater Connections Improves Its Operation

A SIMPLE change made in the oil connections of a multi-coil fuel-oil heater greatly improved its operation. To heat the oil, which as a rule was of a low gravity, it was necessary to carry between 100 and 125 lb.




*Series parallel connection of fuel-oil heater*

steam pressure at the heater. I thought this was unusually high and decided to try a few changes in the heating arrangement.

The original method was to have the oil flow counter to the steam and all heaters were connected in parallel as to steam and oil. I made no change in the steam connections or direction of flow, but the oil heating coils were connected in series. That is, the oil was forced to pass through each heater consecutively, entering on one end of the series of heaters and discharging at the other end.

Perhaps this is contrary to best engineering practice, but results quite justified the change.

The alteration made in the connections consisted of substituting four tees for elbows and adding nipples and unions, as indicated by the dotted lines. This permitted the heater to be run the old way in case of a break in any of the coils, which could not be done with the heaters connected in series, without shutting down the whole system.

The valves *B* were opened to operate the coils in series and valves *A* and *C* were left closed. For repairs to any individual coil, valves *B* were closed and valves *A* and *C* opened, then the single bad coil was cut out by closing off its valves.

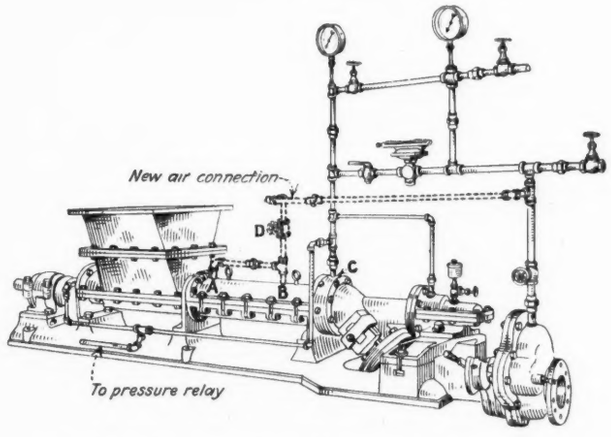
This change permitted us to drop the steam pressure from 100 lb. to between 25 and 30 lb. and a more uniform temperature was maintained on the oil.

RUDOLPH BOETTINGER.

Union City, New Jersey.

## Preventing Plug-Ups on Pulverized Fuel Transport Pump

WHEN our plant was first started up, there were occasions when considerable quantities of wet coal were delivered to the fuel transport pump. Also, at times slugs of the accumulation that formed on the inside of the long vent pipes, due to this moisture condition, would fall into the pump and cause plugging. This




*Additional air connection to screw barrel prevented pump from plugging on wet coal*

trouble could, of course, be eliminated by arranging always to have dry coal, which in itself will not plug the pump and which will not give off enough moisture to condense and cause a mass of wet coal to adhere to the sides of vent pipes. Much can also be done to prevent plugging by arranging the vent pipes so that when these slugs do fall, they cannot fall directly to the pump hopper. It is not always possible, however, to rearrange a plant to accomplish these ends, and when such abnormal conditions prevail, the arrangement of air connections, as here described, will be found a material help. In this case it was so effective that the pump has been operated for ten months without its becoming plugged.

The upper cover casing and top half of the barrel were removed. At *A* and *B* holes were drilled for ½-in. pipe through both cover and barrel, the former being tapped for nipples and connections made through a gate valve to the main air supply line. Point *A* was made 1 in. from the hopper flange and *B* 8 in. from the air-ring flange for the reason that the air on the ring would help to clear the screw at *B*, while it was necessary to keep the fuel agitated at this end. Possibly an additional connection midway between these two would have been helpful, but it has not been found necessary.

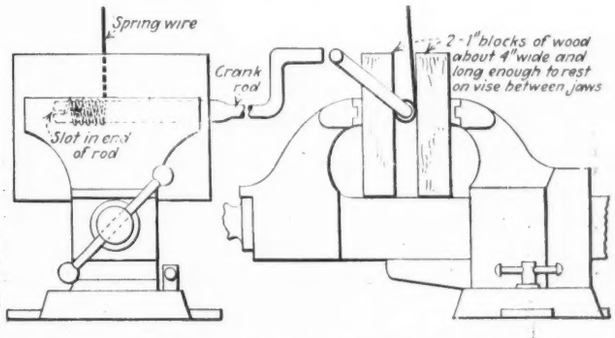
In operating, the procedure followed is to open the air valve to the ring supply *C*, start the pump, then open the valve *D* to connections *A* and *B* for about a minute. Before shutting the pump down, this valve is again opened, but usually for a longer period. Should the pump start to hammer while running under load, thus indicating that a mass of wet coal has been introduced into the pump, the valve *D* may be opened until the pump is again running quietly.

For the first year of its operation the plant was not equipped with protective relays, and ability to free the pump from this plugging was of great help to the operator in maintaining service. Recently, relays have been installed, which cut out in proper sequence any apparatus that is affected by abnormal conditions. Perhaps the most important feature of this arrangement is that the plant is foolproof on starting up. The air pressure relay originally had its supply from the main line, being set to pick up at a predetermined value. We found that we could start the pump, but not necessarily have air on the ring, so we connected the relay pressure line into the air-ring supply line on the low side of the reducing valve. Now it is impossible to start the mills or screw feeders unless the pump has air on the ring and is running.

Sanford, Me. E. S. WOODWARD.

## Winding Small Tension and Compression Springs

NOT infrequently, engineers find a need for a small tension or compression spring for a special application of some piece of apparatus in the plant. As it is not always easy to specify the exact type of spring




*Spring winder in position in vise*

required, to permit ordering it from a spring manufacturer, it is usually more practical to wind a spring at the plant. The illustration shows how springs, either for compression or tension may be wound easily and evenly.

Make a crank from a piece of iron rod of a slightly smaller diameter than the inside diameter of the spring desired. The size depends on the size of wire used and can be easily determined after winding a few springs. The rod is slotted in the end to hold the wire.

To wind the spring the crank rod is clamped in a vise between two blocks of wood, the slotted end being between the blocks with the slot parallel with the surfaces. The end of the wire is placed in the slot and the crank turned just enough to hold the wire. Now if a tension spring is to be wound, the wire is started and wound close by feeding the wire perpendicular to the crank rod. If a compression spring is to be wound, the wire is started at an angle of less than 90 deg. with the rod—the less the angle the farther apart the coils will be. It is important that the first coil have the right angle, as every coil after the first one will be just like it, or symmetrical, and that is what makes a neat spring. A spring of any desired tension can be wound.

Denver, Colo. F. R. RAWSON.

# *As the Other Fellow Sees It*

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

### *Pin It Down*

THE editorial in the June 26 issue entitled "Pin It Down," outlined a proposition that I have encountered in several instances. There is also another inconsistent procedure followed at the plants voicing the argument that their costs all go toward the same article.

Usually, these plants have a complicated cost system whereby department A or department B, etc., is charged for a gasket, a bolt or a small valve when it is obtained from the storeroom by a requisition. These small items are all added up on tabulating machines with a great deal of accuracy, and a cost is arrived at at the end of the year for that department that is totally inaccurate, owing to the fact that they do not know whether $10,000 worth of steam, water or electricity was used in that department or whether it was actually $100,000 worth.

It has always seemed inconsistent to take such pains in tabulating such small items, and at the same time overlooking the big items. J. W. HOGG.

Chicago, Ill.

* * * *

### *Low Pay for the Engineer*

THE editorial in the May 15 issue, entitled "Low Pay for the Engineer," gives one much food for thought. I think the answer is simply that the engineer is not in a position to help himself. His position in our economic structure is entirely different from that of the lawyer and the doctor.

If a doctor decides that $2 is too low for a professional visit, he can charge $3 or $4 or whatever he wishes, and if he has a reputation for good work, he will be able to collect the fees he charges. Likewise, a lawyer has his own clients, and his charges for his services are what he considers they are worth. In both cases everything that comes in goes into the professional man's pocket, because he is in business for himself and he can pocket all the profits.

An engineer, on the other hand generally works for someone else, usually a power company, a construction company or a manufacturing company, and he is paid a salary. His job is generally rated as being worth so much, and that is what he gets, irrespective of how the business may progress. Of course, if the business goes on the rocks, he must look for another job. His chance of more pay lies in his being promoted to a more responsible position in the organization. Promotion does not always come, because a man may be brought in from the outside, and then again favoritism is sometimes shown.

A doctor may perform a difficult operation and save the life of a wealthy patient, or a lawyer may win a difficult case for a wealthy client. In either case he is well paid for his work. If an engineer invents a new process that saves his employer thousands of dollars, he knows he may be that much surer of holding his job, but the increased profits go to the stockholders.

Personally, I believe the engineering profession has done more than any other for the physical comfort and material progress of the world. It may seem unethical that the class mainly responsible for prosperity should not be able to command a higher degree of it, but it seems to be nobody's fault in particular. The engineer is essentially a salary worker, and those responsible for paying salaries are naturally guided by the law of supply and demand.

If anybody wants to be an engineer, he should go into the work for the love of it and not become "soured" to see some lawyers and doctors of relatively smaller natural ability getting bigger returns for their work.

Boston, Mass. E. F. ROGERS.

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### *Is Spare Equipment Worth the Cost?*

I HAVE noted in your May 1 issue the editorial, "Is Spare Equipment Worth the Cost?" and it makes me sit up and take notice. It is a well-known fact that time lost can never be regained, and certainly when any factory is thrown off its routine of work, it must of necessity cost money. Until such a time as the power companies can get a 100 per cent "tie-in" with their neighboring companies so that factories will not be forced to shut down temporarily due to lack of power equipment or weather conditions, it would seem to me that spare equipment is most essential.

It must not be forgotten that peak loads are paid for at the rate of $1 per kw. or at a higher rate. When one is compelled to pay for a two-minute peak at a rate as high as $200 or more, and then when forced to close down for a period of 5¼ hr., receives a rebate from the power company for interruption of service of $0.72, it makes the factory management feel that there cannot be too much precaution taken in furnishing continuity of service.

ROBERT G. NYE, Factory Manager,
Buffalo Steam Pump Company.

North Tonawanda, N. Y.

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### *Removing Slag from Boiler Tubes*

REFERRING to the request of R. N. Seldon in the March 13 issue for practical suggestions for eliminating slag on the bottom row of boiler tubes, a brief review of some of the methods used during the last few years for combating this condition may prove helpful.

When high ratings became general practice, with combustion proceeding at a more rapid rate than had formerly been the case, slagging of the lower tube rows became a serious problem. The first means for handling this condition was to deslag by hand. The boilers were run until a heavy accumulation of slag had collected, when they were taken off the line and the slag knocked off by hand. In many cases this was a difficult process.

The next step in the deslagging development was that

of using cold water. This had the advantage of not requiring closing down of the boiler, but it soon developed that the repeated cooling action of the water on the boiler tubes and headers caused serious loosening of the tubes with consequent leakage.

The latest means of deslagging is that reported on pages 17 and 18 of the 1924 edition of the Prime Movers Committee Report of the National Electric Light Association, covering boilers, superheaters and economizers. Therein it is stated: "One set of curves shows the evaporation of boilers 1 to 12, inclusive. Starting about the first of March, the number of times the boilers were manually deslagged, which was done when the boilers were off loads at week ends, has been indicated. It is also shown that after the soot-blower elements were installed on both sides of the boilers, this hand deslagging was not necessary, which reduction in labor expense has been the greatest apparent benefit to us of these elements."

G. L. DAVIS

Detroit, Mich.

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## *Concrete Pit vs. Overhead Ash Bunker*

RECENTLY, a paper presented before a meeting of the A.S.M.E. at Philadelphia, made a statement that could be construed as a claim that a concrete pit is a cheaper means of handling ashes outside a boiler house than an overhead bunker.

The facts to be considered on both sides of the case are simple and well-known, but a statement of them at this time may be of interest.

Any storage receptacle is essentially a device to balance out the difference either in the rate or the time of the material entering or leaving the receptacle.

Usually, the material enters the reservoir rapidly and leaves it slowly or vice versa. With an ash receptacle the material enters the receptacle at infrequent times at a comparatively slow rate. A high rate of discharge is always economical.

Machinery of some sort is required either to fill the receptacle or to empty it, or both. In general, it is more economical to employ some simple type of equipment to fill the receptacle because the rate of filling and consequently the cost and size of the apparatus are small. Such mechanism is usually capable of elevating the material any practical height with slight additional expense. Economy, therefore, indicates that an elevated bunker ads little to the cost of the mechanism employed to fill the bunker and at the same time permits a high discharge rate by gravity without the employment of any machinery.

As a rule evolution is a better guide than engineering or ideas. We engineers believe that progress is best obtained by new ideas and improved methods. Too often, however, we fail because of our lack of knowledge, experience or appreciation as to the fundamental economics embodied in devices and methods produced through years of evolution. An overhead bunker is an old idea, and it is still an essential idea and its engineering and economics are sound, although not always self-evident.

Undoubtedly, the cheapest receptacle is an elevated bunker. It is cheaper to place a shell in the air than below ground. If it is placed below the ground, it can be readily filled but expensively emptied. If the filling of the receptacle is slow and its emptying rapid, then it is cheaper to employ machinery to fill the bunker and gravity to empty it. This reason merely leads us to a common solution of the problem by using an overhead bunker and a simple elevating device to raise the material into the bunker.

Another reason for a receptacle is to avoid any possibility of a shutdown. If machinery must be used to fill the bunker, additional machinery should not be used to empty it. It is possible that the machinery used to fill the bunker may be out of service occasionally; likewise, the machinery to empty it. It is unwise, therefore, to depend on machinery where gravity or other more certain and less costly means can be employed. A locomotive crane is commonly used to empty an ashpit. A locomotive crane is costly both initially and for maintenance. Its operation is not cheap. It is not always in service and it is not always available. One argument for using the locomotive crane is that it is a handy tool around the plant. It would be much better reasoning, it seems to me, to use a device that was not a handy tool but strictly a simple, special appliance to fill the bunker and depend upon gravity to empty the bunker. There is, then, no chance of this device being employed for other service and not available when wanted. The problem is correctly solved by the use of such a device, inasmuch as it is a comparatively low-cost, low-capacity apparatus for filling, and eliminating all machinery for discharge.

In short, a pit below ground cannot compete economically with a receptacle above ground for the same capacity and service.

R. H. BEAUMONT, President,
Philadelphia, Pa. R. H. Beaumont Company.

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## *Why Scrape a Bearing to Fit?*

REFERRING to the article by B. M. Adams in the May 22 issue on "Pouring a Four-Piece Adjustable Bearing," that part of the article which relates to the elimination of the process of "scraping" interests me.

With the possible exception of machinery which is built to produce work of extreme accuracy, why should it ever be necessary to scrape bearings? I am satisfied, from personal experience and observation, that it is unnecessary to resort to scraping after the bearings have been properly machined, especially in the case of bearings that are lined with babbitt. It seems to me a waste of time to machine bearings and then to follow that by scraping, thus virtually boring out by hand what was presumed to have been done in the machine. If it is necessary to resort to scraping, why machine a babbitted bearing at all? There have been cases in which babbitted bearings have been "run in" without either boring them out in a machine or using a scraper on them, and good results secured.

I am aware of the possibility of bearings becoming "sprung" owing to the introduction of the hot metal when rebabbitting, or becoming distorted owing to incorrectly clamping the bearings in the lathe or boring mill. This may be used as an argument in favor of scraping. The former cannot always be prevented, but the latter can by a careful and skilled workman.

The old-fashioned idea was to bore out a bearing a trifle smaller than its journal and then scrape it to fit until it "crowned." Why not bore it out a trifle larger so that it will "crown" right away? I have had much to do with rebabbitting, boring, fitting and adjusting steam-engine bearings, and at first I was a believer in the use of a scraper to finish with, but I finally came to the conclusion that in cases scraping was not necessary.

My ideas on the subject were put into practice with a number of 1,000-hp. cross-compound Corliss condensing engines. The bearings in question—the crankpin and cross-head-pin bearings—were 6 in. in diameter and 6 in. long. There were quite a number of these bearings to be rebabbitted and fitted. They were bored out the thickness of newspaper stock larger than the pins, then the sides were eased off, the sharp edges rounded, oil grooves properly cut, and the raised burrs taken off. When they were tried on the pins they were found to bottom or "crown" properly so were put in place on the engine without further fitting. The engine was then brought up to speed and run light for about fifteen minutes while copiously supplying the pins with oil. When we found that there was no tendency for the pins to heat, the full load was put on the engine, and the watch was run through without any mishap. When the engine was shut down the pins were again stripped and the bearings examined and found to have as good a surface as could be desired. Thereafter we never scraped bearings in that power station, nor did we ever "lose" a bearing. CHARLES J. MASON.

Brooklyn, N. Y.

* * * *

## *Oh, That Percentage Change!*

A SUBJECT of considerable interest is raised by the answer to Ques. 9 in "What Do You Know?" in the issue of May 1. The question asks the change in starting torque of an induction motor due to a change of voltage from 10 per cent above normal to 10 per cent below normal. The answer says, "The change in torque is 50." This is followed by an explanation that seems to me quite correct, but I think the 50 per cent change ought to be given as 33⅓ per cent. The figures quoted are approximate. The original torque is 121, the torque after the change in voltage is 81, the reduction in torque is 40, and 40 is taken as approximately 50 per cent of 81.

So far, so good, but the question does not ask for the reduction of torque as a percentage of the torque after the change, but of the original torque. To avoid complication due to the odd unit, take the actual torques as 120 and 80. The reduction is clearly 33⅓ per cent. It is true that the increase needed to restore the original torque would be 50 per cent, but that is not what the question asked.

There ought to be some clear understanding as to the naming of such relations. The lack thereof frequently leads to confusion and sometimes to actual misunderstanding and loss.

There is an old joke current in England and, I dare say, also in America which well illustrates the point. A man called on his tailor, to whom he owed £100, and said that he had come to pay but would like to be allowed to deduct 50 per cent. The tailor replied that he could hardly allow so heavy a discount. The customer replied, "Ah, but I would then add 50 per cent, so you would not have any objection." The tailor, thinking the sum would thus be restored to £100, said; "Oh, now, that will be all right." The customer proceeds to deduct 50 per cent, leaving £50, and then adds 50 per cent, making £75, which he pays. The tailor had agreed and could say nothing, yet he lost £25.

As an instance of the importance of clear nomenclature in this matter, a relative increase of 10 per cent in boiler efficiency, as from 70 to 77 per cent, does not give a 10 per cent reduction of fuel consumption for equal output, but a reduction of one-eleventh, or a little over 9 per cent. I have known this difference, when not clearly expressed, to give rise to disputes over equipment performance guarantees, and the same may occur in many other cases.

It is for such reasons that I wish to appeal, through *Power* for some definite, recognized wording for all such cases. Your question and answer, mentioned herein, gives me the opportunity. G. A. ROSSETTI.

Lancashire, England.

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## *Discolored Ice*

REFERRING to the article entitled, "Why the plant sells discolored ice," in the June 26 issue, I wish to advise that I have had considerable experience with discolored oil.

Upon investigating various complaints in plants where the exhaust steam is used for ice manufacturing purposes, I have found that nearly always the trouble has been due to some dirt or matter collecting in the system and has not been due to oil. However, I have found a few cases where oil had been responsible, owing to poor separators on the line. In such cases the discoloration was always present in a fan shape at the top of the cake and not near the center parts, which is natural, taking into consideration that oil will attempt to seek the upper level when in the presence of water.

Of course one is always "between the devil and the deep sea" when using the exhaust steam for ice manufacturing purposes, so far as discoloration is concerned. When one operates on a straight mineral oil, the consumption of cylinder oil is bound to increase, especially if wet steam conditions are met with. On the other hand, when compounded oils are used, it is difficult to remove it in the reboiler and consequently the ice becomes discolored. The best thing to do is to consult oil companies specializing in lubrication. M. H. STRINDLER,

Lubricating Engineer, The Texas Company.

Chicago, Ill.

* * * * *

## *A "What Do You Know" Answer Is Questioned*

REFERRING to Question 7 of the "What Do You Know" column, in *Power,* July 3, explaining why the coils in a refrigerating evaporating system should be supplied with plenty of liquid ammonia, is it possible to keep the coils full of liquid as suggested in the answer?

Even in the lowest run of pipe the liquid necessarily begins to evaporate, and each higher pipe must contain a smaller proportion of liquid and a larger proportion of vapor. So long as any liquid at all is present, the vapor cannot become superheated.

In other words, it is desirable that all the coil be kept *wet* with liquid ammonia, rather than *filled.*

New York City. EDGAR J. KATES.

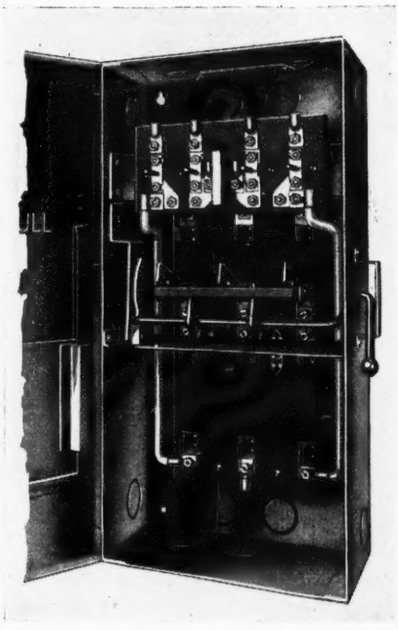
[In a water-tube boiler the tubes are filled with a mass consisting of water and steam bubbles, nevertheless it is common practice to speak of the water level in the drum. This level is that plane at which the steam leaves the mass. Likewise, in an ammonia coil there is no gainsaying that even the lower pipe holds some vapor bubbles. Nevertheless, there is a disengaging surface and this level should be kept as high as possible.—*The What Do You Know Editor.*]

# What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

## Polyphase Service Switch

A NEW line of polyphase meter-service and entrance switches has been announced by the Trumbull Electric Manufacturing Company, Plainville, Conn. The switches



*Switch with inclosing-case cover open*

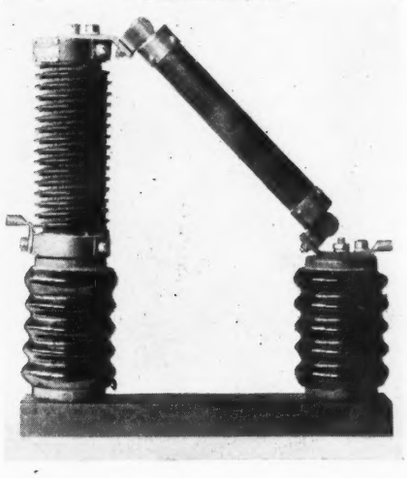
are known as type C, and are available in sizes with test connection, for 30 to 400 amperes and without test connections for 30 to 600 amperes.

These switches are of slate-base construction, as shown in the figure, the contacts being mounted on top where they can be easily inspected. They have accessible fuses, but are equipped with an interlocking device so that the fuse compartment cannot be opened unless the switch is in the open position. When the fuse compartment is open, the switch cannot be closed. Quick-break attachments are provided on the switch blades, so that when they open they come to a full open position to prevent burning of the contact on holding an arc.

The top of the switchbox is provided with a shutter that will accommodate the two sizes of single-phase meters and also the new 5- to 75-ampere standardized bottom-connected polyphase meter. The switches can be furnished with or without testing facilities in boxes having either sealable covers or with a slide which gives access to the fuses when the switch is in the off position.

## Fuse and Wire-Wound Resistor for Transformer Protection

THE Westinghouse Electric & Manufacturing Company announces a Type H combination potential transformer fuse and wire-wound



*Combination potential transformer fuse and wire-wound resistor*

resistor for 2,500- to 25,000-volt service. It is intended for indoor application and can be mounted on any flat surface or on 1¼-in. pipe.

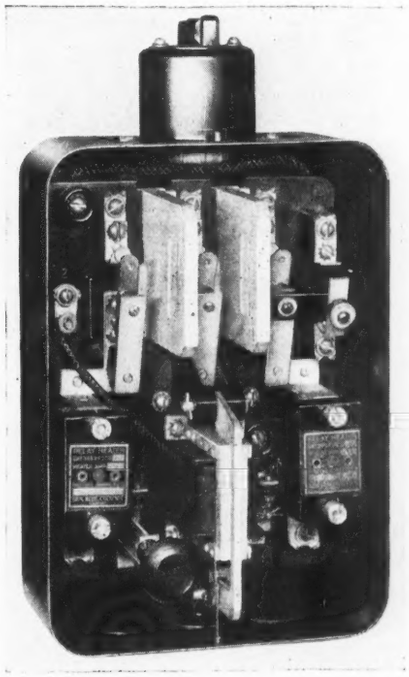
The resistors are placed in series with the fuses and effectively limit the current in case of short circuit. This permits the use of potential transformer fuses on any circuit regardless of its short-circuit amperes, provided the voltage rating is not exceeded.

The resistors are made up of coiled nichrome wire wound in the grooves of a heavy wet-process porcelain tube. They are combined with fuse, fuse mountings and insulators as shown in the figure. The resistor may be mounted either in line with or perpendicular to the insulators. This permits the apparatus to be adapted to space requirements.

## Hand-Control Switch Mounts on Any Starter

FOR application where it is desirable to control a magnetic switch at the switch itself, the General Electric Company has designed two small control switches. These may be mounted in the knockouts of the inclosing case of any starter and are held rigidly in place by a conduit bushing which forms part of the switch, as shown at the top of the figure.

One class is a maintaining-contact type whose action is similar to a single-pole, double-throw switch. It is provided with three positions—"Hand," "Off" and "Automatic." The most general application of this switch is in connection with re-



*Control switches mounted on top of magnetic starter*

frigerating machines controlled by thermostats, but it can also be used where float switches, pressure governors, etc., are used in the same manner as a thermostat in various applications. When the operating lever of this switch is in the "Automatic" position, the thermostat, float switch or

governor controls the machine. On the "Hand" position the machine runs continuously, and in the "Off" position the control circuit is opened.

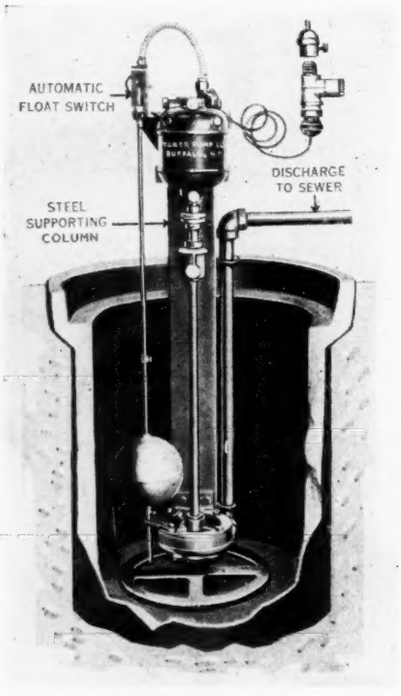
Another type is a two-position, momentary-contact switch provided with the positions "Start" and "Stop." This is the equivalent of the usual push-button station of the same marking. It is most applicable where starting or stopping of the motor is necessary at the magnetic switch itself.

Both switches are equipped with leads ready to wire and have sufficient capacity to handle any magnetic starter up to 75 amperes capacity. They can be used on 600-volt circuits with safety, as their insulation is designed for maximum safety to the operator.

## Taber Midget Sump Pump No. 2

THE Taber Pump Company, 288 Elm St., Buffalo, N. Y., has added to its line of sump pumps the small-capacity pump illustrated.

The pump is of the self-contained,




*Self-contained sump pump*

self-supporting type, designed for placing directly on the bottom of a sump or well without the use of a supporting cover to fit the various sizes of pump casings. It may also be suspended from the side of an 18-in. tile or tank by means of a bracket.

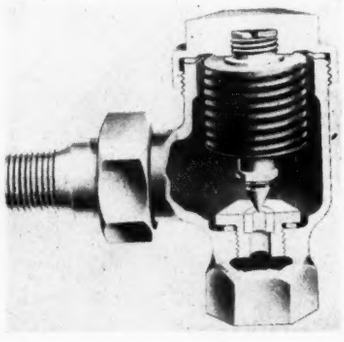
The various parts of the unit, including the motor, the ball thrust bearing, pump and automatic float control, are assembled on a steel supporting column, thus insuring permanent alignment. The pump is driven by a standard ¼-hp. moisture-proof repulsion induction motor connected to the pump shaft through a flexible coupling.

The pump is of the balanced open-impeller type and is built in capacities up to 25 gal. per min. and for a total head of 23 feet.

## Sarco S-75 Trap for Process Steam

IN THE type S-75 trap for process steam put out by the Sarco Company, Inc., 183 Madison Ave., New York City, the operating element consists of a heavy-wall helical bellows with a renewable monel-metal valve head and seat.

The operating element is supported



*Cutaway view showing thermostatic element*

from the cover and is designed to be self-adjusting from 0 to 75 lb., which permits the trap to be used on widely varying pressures.

The trap is small and light in weight and is claimed to have unusually large capacity and quick high lift when discharging. The ½-in. trap has a capacity of 400 lb. of water per hour.

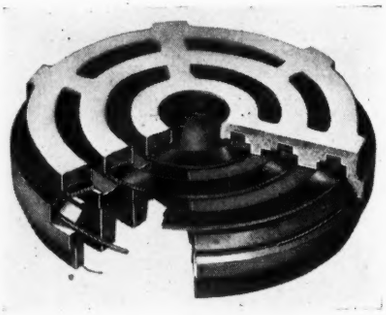
## Pennsylvania Improved Air-Cushioned Valve for Compressors

SIMPLICITY of construction is a feature of the improved air-cushioned valve for compressors recently introduced by the Pennsylvania Pump & Compressor Company, Easton, Pa.

The valve consists of four principal parts—seat, guard, disk and springs. The seat is made from a casting of close-grained structure, while the special malleable metal used in the guard resists breakage and wear. Tough, tempered spring steel is used for the valve disks, which are ground flat.

An important feature of the valve is the air-cushioned pocket in the guard. As the valve opens, instead of striking the guard, the disk enters this air pocket and the air trap in the pocket provides a cushion which prevents the valve from striking the metal of the guard.

The valve disks are guided by a



*Improved air-cushioned valve*

number of columns on the guard that supports the valve above the seat, the movement of the disks being accelerated by small spiral springs in the guard. The valve assembly is held together by means of a retaining ring which engages the valve guard and seat. This ring fits in a recess around the inside of the flange of the valve guard, and normally remains in this position. When the seat and guard are brought together, this retaining ring snaps into a corresponding groove around the edge of the valve seat.

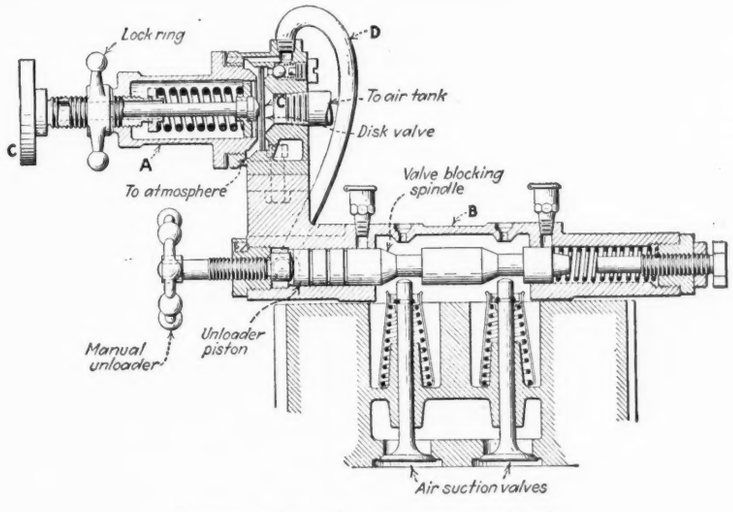
The use of retaining rings instead of screws has made a valve that is interchangeable in both the inlet and discharge assemblies and has permitted larger port areas. The valve assembly is held firmly to its seat in the cylinder by the clamp which is brought up tight against the assembly by means of a valve-cover setscrew. When the setscrew is drawn down, it brings the pressure of the yoke on the outside rim of the seat or guard and cannot, therefore, exert pressure in the center of the valve seat, which might tend to distort it. The large air ports with which the valve is fitted permit the passage of a maximum volume of air with the least resistance, thus increasing the operating efficiency of the compressor. An additional air passage is provided by a central opening through the guards.

## Compressor Unloaders for Diesel Engines

AN AUTOMATIC air compressor unloader for use with Diesel engines where the compressor is direct connected to the engine, is a recent development of Fairbanks, Morse & Company, Chicago, Ill. The unloader has been designed with a view to eliminating the usual manual control necessary and to insure a constant supply of starting air.

The unloader has two main parts, a pilot *A* connected to the starting air tank, and a valve blocking mechanism *B* on the compressor. The device for holding open the suction valves of the compressor is the same as the one furnished for manual cutouts, but is capable also of being operated by air pressure communicated from the pilot.

Inside the pilot is a plain disk valve *C* loaded by a spring and capable of moving a short distance between the two opposite valve seats. The seat against which the spring ordinarily pushes the disk is of smaller diameter and is connected to a one-half inch line leading to the air tank, whereas the seat that is situated opposite this one is of slightly larger diameter and free to the atmosphere. When the pressure is low, the spring holds the disk against the small seat, and when the pressure is high it overcomes the spring and holds the disk against the larger seat. Owing to the larger area of the outside seat, it develops the same force from the lower air pressure that is necessary to start the valve off the small seat.



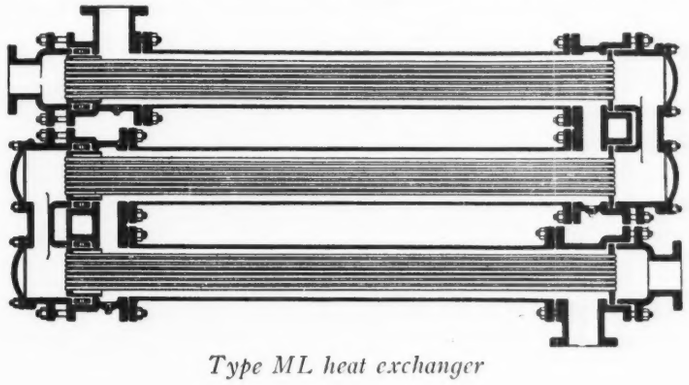

*Cross-section of compressor unloader*

Between the two valve seats is a small connection leading to the unloader. When the valve is held by the spring against the small seat and shuts out the air-tank pressure, the space between the seats is open to the atmosphere and does not allow any pressure to act on the valve blocking system. But as soon as the valve is lifted, air under pressure fills the space between the seats as well as the small connection leading to the unloader, which is thereby moved against the force of a light spring provided for returning it.

The piston of the unloader carries a spindle with conical shoulders and necked-down portion, the latter being opposite the compressor valve stems when the compressor is delivering air. As soon as the pilot admits air behind the piston and moves it, the conical portions of the spindle slide up on the ends of the compressor valve stems and hold the valves open. The compressor is thus unloaded. When the pilot closes the tank line, the connection to the unloader is vented to the atmosphere. The piston then releases the compressor valves. A handwheel with a screw is provided for holding the unloaded piston in the cutout position for throwing the compressor out of action independently of the pilot.

## Multi-Pass Heat Exchanger

THE multi-pass, type ML heat exchanger illustrated herewith has been brought out recently by Struthers-Wells Company, Warren, Pa. The exchanger is made in shell diameters from 8 to 24 in. and in tube lengths 6 to 20 ft. The exchanger can be furnished in steel, cast iron or various alloys, with tubes of steel, brass, copper or alloy. The standard construction permits of a working pressure of 125 lb. for both shell and heads, but can be supplied for pressures up to 500 lb. or greater in the shell, and 150 lb. in the head. Larger diameter units than 24 in. can be made to order.



*Type ML heat exchanger*

The exchanger is especially adapted for heat exchange between two fluids where a small end-temperature difference is required. Any number of units—three being shown in the illustration—may be connected together to give the desired temperature characteristics.

An important feature of the construction is a provision for tube expansion with a minimum of packed joints, and the prevention of interleakage between the two fluids. The stationary tube plate shown at the left of the drawing is packed on either side and tightened by means of the heads. The movable tube plate at the right slides in contact with packing, which is separated at its center by means of a circular spiral spring. Leakage passing the packing from either fluid escapes into the space occupied by the spring, and thence through a drilled hole from the casing.

Another feature is the elimination of baffling, with the possibility of short-circuiting. The sections may be arranged with valves and bypasses to cut out any part for cleaning or repairs. In case of accident, any tube bundle may be readily removed and replaced.

# Design of Pressure Vessels
## *for the Petroleum Industry*

By T. McLean Jasper
*Director of Research*
*A. O. Smith Corporation*

*This paper, slightly abridged from that presented on May 31 at a meeting of the Western Refiners Association, has an interest that extends beyond the oil refining industry. Wherever pressure vessels must operate safely and without leakage under high pressures and at high temperatures, the information presented by Mr. Jasper will be of practical interest to the engineer.*

THE subject of the design of pressure vessels for the petroleum industry is one that demands the most up-to-date and reliable engineering information.

The economics of the problem of design requires that vessels shall be constructed in a manner that insures that they are equally strong in every part. It also requires that the strength shall be adequate to take care of the working loads put upon vessels under conditions of service.

The oil-cracking industry is engaged in one of the most hazardous peace-time businesses which contributes to the comfort of man. It deserves, therefore, the most careful co-operation from those supplying equipment in order to insure adequate safeguards against unnecessary risks.

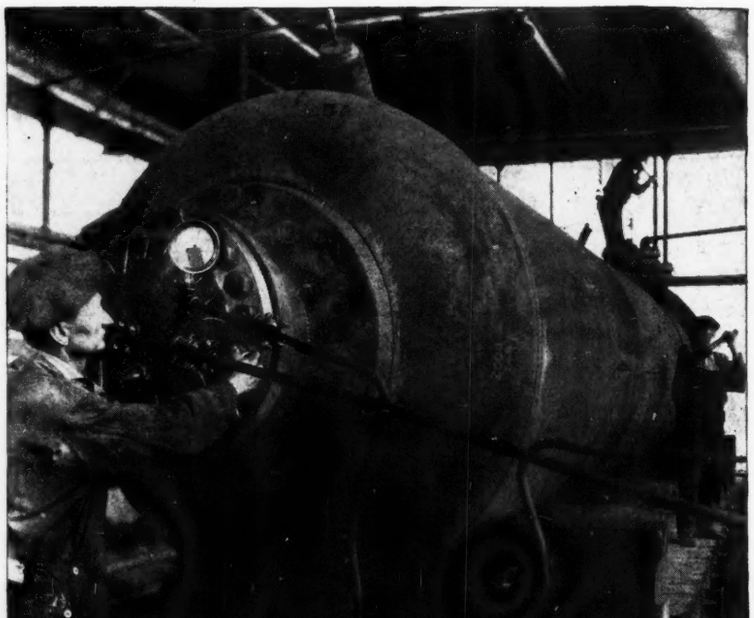


*Fig. 2—Hammering all seams with sledges is part of the elaborate test procedure*

The question of vessel design divides itself into three main divisions; (1) The strength and kind of the steels most suitable for conditions representing normal service; (2) the effect of shape of heads and other parts of vessels and reinforcement at points of discontinuity; (3) the ability to produce a ductile leakproof 100 per cent joint in the construction of vessels.

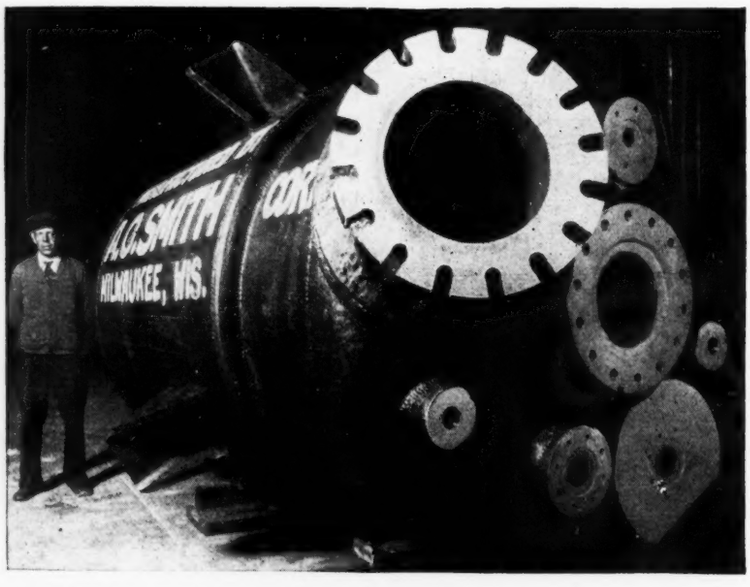



*Fig. 1—Jacketed autoclave of 54-in. inside diameter, 11 ft. long, with 3-in. wall. It weighs 35,000 lb. and is designed for a working pressure of 900 lb. per sq.in.*

It has become recognized that 900 deg. F. is a temperature around which oil-cracking operations can economically be carried out. However, it has been found that the long-time strength of metal at this temperature is much less than that ordinarily considered. It is also becoming more apparent that for the oil-cracking industry the best steels are the plain carbon steels, because the strength increase obtained in using the ordinary alloy steels at elevated temperatures is not sufficient to cover the higher costs of the steel and increased costs in fabrication.

The advantages gained in corrosion resistance for such alloy steels do not become apparent until very expensive alloys are used, which usually are high in chromium or both chromium and nickel. However, some of the very high chromium steels appear to have the disadvantage of becoming exceedingly brittle at the high temperatures involved, and for this reason the dangers of fracturing must be guarded against. On the other hand, some high-alloy

steels seem to avoid the difficulty of brittleness, especially those containing nickel as well as chromium.

To overcome corrosion in the oil-cracking industry, the ordinary carbon steels have in some cases been coated with an electro deposit of chromium. In others a coating of inert siliceous material has been deposited, and in still others liners have been provided, especially in and around gas line outlets where the effects of corrosion and erosion are most pronounced.

That the short-time test results do not produce correct values to be used in design is shown by the difference between these values at 900 deg. F. for two plain carbon steels.

| | Ultimate Strength at 900 Deg. F, Lb. per Sq.In. | |
|---|---|---|
| | Short-Time Test | Long-Time Test |
| *SAE 1100 | 32,500 | 15,000 |
| *SAE 1025 | 35,300 | 18,000 |

* Society Automotive Engineers Specifications.

It is quite obvious from the foregoing data that if the short-time test results

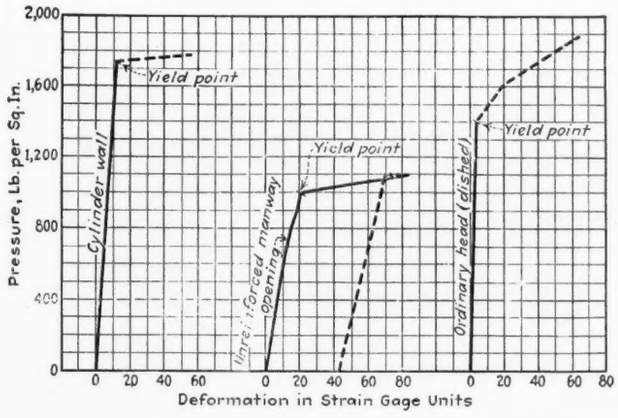



*Fig. 3 — Strain values in the cylinder, at the most stressed situation around an unreinforced manhole opening and at the most stressed situation in a dished head*

In general it might be said at this time that the best solution of this problem is to allow the stresses in the vessel incidental to the oil-cracking process to be carried by a plain carbon steel while the corrosion effects, where they are important, may be guarded against by the use of some kind of corrosion-resistant lining.

The strength of various steels at elevated operating temperatures is a matter in which short time tests give very erroneous results when considering the long time loading to which a vessel is subjected. The company with which the writer is associated has been furnishing

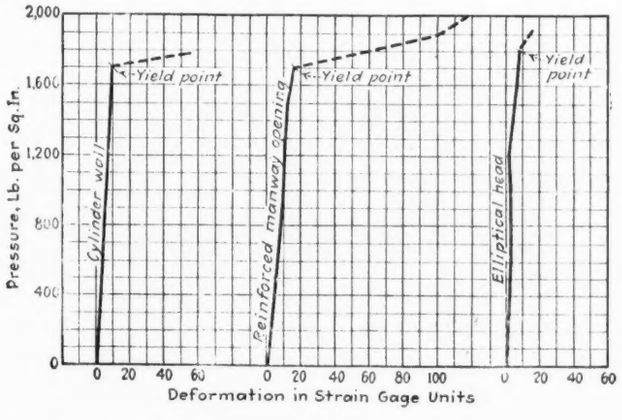



*Fig. 4—Same as Fig. 3, but with manhole opening reinforced and with elliptical head*

hundreds of oil-cracking vessels which call for continuous operation at 900 deg. F. The long-time strength of the metal at this temperature is, therefore, of great importance. This has necessitated the installation of a considerable battery of testing machines at our laboratory. These operate continuously night and day to furnish test data on various steels.

are used in the design of vessels, the actual safety of the vessel when under continuous temperature would be about one-half of that expected. A description of the long-time method of testing steel at elevated temperatures with a sketch of the testing machine used can be found in a paper presented before the American Petroleum Institute Dec. 8, 1927, and contained in proceedings of the eighth annual meeting published Jan. 31, 1928.

The corrosion of metal under high pressure and high stress and at various temperatures is an important factor. It is unwise to base the answer to this question on test results that do not closely approximate the anticipated working conditions. We know, for instance, that the corrosion rates of metals, hung unstressed inside a vessel in operation, are not as high as when the specimens are stressed equally with the vessel walls. The pressure intensity on the inside of a vessel also affects the rate of corrosion.

Similarly, we have evidence from the oil industry that the temperature has considerable effect on the rate of corrosion, and that for certain temperature ranges this corrosion rate for a given pressure and condition of stress in a vessel does not necessarily increase as the temperature increases. It is difficult to draw even general conclusions from tests that do not closely approximate the various conditions of operation.

The effect of the shape of various parts of vessels is a matter of great consequence. The importance of this question has increased as larger vessels of thicker walls have become essential

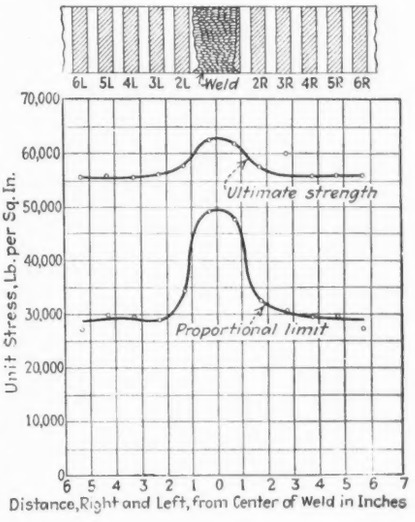



*Fig. 5—Results of tests of specimens taken from different locations*

to more economical industrial development.

The goal to be kept in view in designing vessels is to make them equally strong in every part. The following statements and test data on the shape of heads and the manner of reinforcing will apply in general as factors in the design of any pressure vessel. For the riveted construction additional facts must be considered; namely, the stiffening effect of overlapping of plates, the lower efficiency of joints due to the removal of metal for rivet holes and the possibility of leakage at comparatively low stresses.

In vessels constructed by the method of welding in which the joint is not made essentially thicker than the main cylinder and in which a joint efficiency of at least 100 per cent prevails, the question of shape of heads and reinforcing only need be considered.

This, of course, always presumes that fabrication strains are eliminated in the vessel construction, as is being done in the particular fabrication methods the writer is associated with, which is the process developed by the A. O. Smith Corporation, of Milwaukee, Wisconsin. It might be appropriate to state that these fabrication strains are removed by the use of an automatically and accurately controlled electric furnace 80-ft.

long and able to accommodate vessels up to 12 ft. in diameter. Incidentally, this is the largest furnace of this type yet constructed.

During the past two and one-half years over six hundred vessels have been built by the aforementioned company, weighing, on an average, 120,000 lb. each. The heaviest vessel weighs about 400,000 lb. and the lightest about 30,000 lb. These vessels have been subjected to temperatures up to 900 deg. F. in combination with pressures up to 600 lb. per sq.in. Vessels have been built for pressures of 1,000 lb. per sq.in. at lower temperatures. The first battery of five vessels has been operating continuously, except for periods of cleaning, at this high temperature and pressure for about two and one-half years.

To obtain accurate knowledge of vessel design, large vessels of the 120,000-lb. class, have been set aside by the company and a thorough analysis has been made of the stress conditions prevailing in such vessels after construction and during pressure up to actual failure. The results of these tests have demonstrated the need for reinforcing all the openings; also that the heads in thick-walled vessels should conform to the best mathematical design for economical stress distribution. These vessels have been put under pressure and the strains at various points recorded as increasing increments of pressure are imposed.

The principal underlying these tests might be described briefly as follows: The metal in all plates of a vessel is tested before the vessel is made. All metal used in vessel construction is ductile and has a pronounced yield point. Strain-gage points are placed in heads and plates and around openings in a vessel in which the physical test characteristics are practically identical.

The gage points are located at every point in heads, around openings and in the main cylinder, in which it is anticipated that the maximum and minimum stresses will prevail. It is presumed, therefore, that yielding will appear first at points in which stress intensification is greatest or, in other words, where the vessel design has the greatest weakness. The amount of this yielding is measured by a two- or four-inch Berry strain gage, depending on the location of gage points.

Fig. 3 is a good example of the test results obtained by using these methods of testing. It shows the pressure at which yielding occurred in the main cylinder in comparison to that which occurred at the highest stressed location around unreinforced manway openings or at the highest stressed location in the dished head of the type generally used in pressure vessels.

The results of these tests have demonstrated the need for reinforcing all the openings in vessel walls. The heads of thick-walled vessels, in particular, should conform to the best mathematical design for economical stress distribution. It is believed that heads for all pressure vessels should be elliptical in shape. An unreinforced manway opening decreases the strength of a thick-walled vessel by 40 per cent and an ordinary dished head reduces the strength of a vessel by an amount that makes it quite undesirable.

The correct shape of head to develop the full strength of the cylinder of a vessel, is one-half of an ellipsoid that has the major axis equal to the diameter of the vessel and the minor axis equal to one-half this value. The minimum thickness of the head should be at least equal to the thickness of the cylinder. The ordinary dished head requires a thickness about one and one-half times the thickness of the main cylinder in order to approximate the strength of the vessel cylinder. This is a disadvantage because the stress effect at the joint between plates of different thickness does not allow them to act in unison with each other and results in a lack of uniformity in stress distribution.

With the oldest method of vessel construction, such as riveting, the joints could never be made to develop more than about 50 per cent of the strength of the metal, because they would leak at this stress. In such cases the ordinary dished heads were capable of developing, without failure, all that such vessels could carry.

It must be apparent from the foregoing discussion that unless a joint between two plates of steel can be made which has an efficiency of at least 100 per cent, there is little point in talking about increasing the strength of the heads by improving the shape or of reinforcing the openings in vessel walls.

The proper design for stresses encountered can be determined, therefore, only with a thorough knowledge of the stress distribution factors in joints and at openings, and these considerations must be properly balanced with the knowledge of the strength of the metal that is to be used.

Fig. 4 demonstrates that, by the use of proper reinforcing and the correct shape of heads, the points of weakness in a vessel can be eliminated. The matter remaining to demonstrate the possibility of a hundred per cent vessel is the method of joining it together.

The ability to produce a ductile, leak-proof 100 per cent joint in the construction of vessels without the necessity of thickening the section at the joint is important. This is possible by welding, as will be shown later. This also has an important bearing in design which, when welding of this type is done, allows for shapes that are not possible in any other construction.

The tests that demonstrate this fact apply to carbon steel which has an ultimate strength of from 55,000 to 60,000 lb.

Fig. 5 represents a test that has been made on a welded plate $2\frac{5}{8}$ in. thick. The test specimens were cut parallel to the weld and of the full depth of the plate. It will be noticed that the weld metal is stronger than the plate metal and that there is no point adjacent to the weld that is less strong than the plate. Fig. 6 represents similar specimens but cut in a direction at right angles to the weld. You will notice that the fracture occurs well out into the stock, or from 5 to 6 in. from the welded section. Also notice that one specimen has been nicked down to reduce the section of the weld and demonstrates a similar result to that shown in Fig. 5, which is that the weld is stronger than the plate.

Fig. 7 shows metal that has been cut entirely from deposited welds. These specimens were deformed cold and demonstrate the ductility of the deposited weld material.

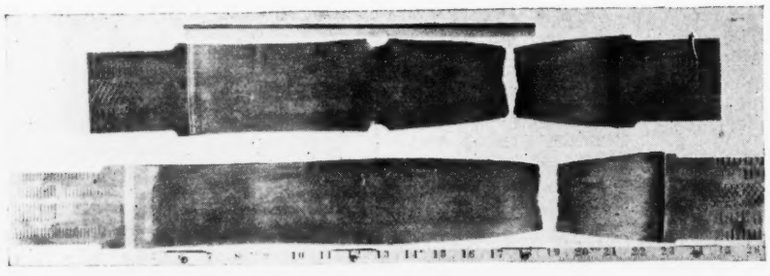


*Fig. 6—Tests of specimens cut at right angles to weld*

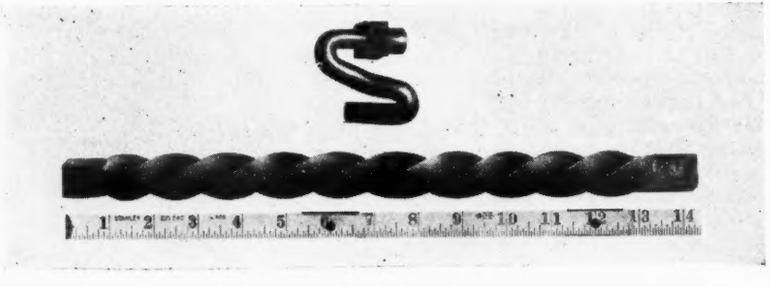


*Fig. 7—Ductility tests of metal cut entirely from deposited welds*

To some the test results on small specimens may not appeal. Fig. 8, however, demonstrates the fact that laboratory test results on small samples are duplicated when a full-sized 6-ft. vessel of 2-in. wall thickness and over 40-ft. length is used as a test specimen.

This vessel was used to produce Figs. 3 and 4 and was then tested to actual failure by hydrostatic pressure. The fracture has in every case avoided the welded seams. It has also avoided the neighborhood of the welds and is a very clear demonstration that the weld in a full-size vessel is stronger than the plate metal and that the metal adjacent to the weld is not affected by the process of welding. The distance from the fracture to the weld is about nine inches.

Please bear in mind that the speaker carries no brief for welding in general, but is speaking specifically and directly of the process which has been developed by the A. O. Smith Corporation, of which he knows.

In summing up, it might be said that all the questions bearing on the design of pressure vessels can be readily checked by laboratory methods, and that a balanced design is the most sensible and safe one to use.

This paper does not deal with the question of theory except so far as it has been used to arrive at what might be considered the best shape in design. The testing of such designs shows that the theory has been applied and tested to a point where it can no longer be considered other than logically proved facts.

*Fig. 8—Pressure vessel 40 ft. long, 6 ft. in diameter, with 2-in. walls, tested to destruction*

# Testing Welds for Ductility

FOR periodic testing of the work of welders and the quality of raw materials, the method outlined herein, as suggested in *Oxy-acetylene Tips* for April, 1928, is said by that publication to be simple and satisfactory. A test similar to this has been described previously in *Power*, Sept. 27, 1927, page 494, when a report of the American Welding Society's Detroit meeting was published. The test described hereinafter is a modification of the first test, in which further experience has led to certain changes, which make it easier to conduct, particularly by the substitution of a flexible steel scale for lines scribed on the sample.

This test shows the actual ductility of the weld metal in a joint, not the strength of the weld or the angle to which a sample can be bent. The only equipment necessary is a vise, a hammer, a center punch and a flexible steel rule graduated in hundredths of an inch.

Controls of the test can be kept by first bending strips of the plate before it is welded and by comparing these with welded specimens. This test is on the weld itself, not on a portion of the plate, as is often the case when a tensile testing machine is used. It shows clearly the ductility of the weld metal in any case, giving a specific figure for its percentage of elongation.

Two plates are prepared, usually three-eighths inch thick, by beveling each on one edge to make a vee and then welding them together, the weld being one inch across at the wide part of the vee. The resulting plate is then cut into strips, across the weld. These strips should be about one inch wide and from three to six inches long, as shown in Fig. 1. The weld should be laid off on these strips, as in Fig. 1, and the punch marks should be made as shown. If the weld has been reinforced, or is rough, it should be smoothed by grinding. The punch marks are laid out by putting one in the center of the weld and then making a punch on each side of this, one-half inch away.

The sample is next placed in an ordinary machinist's vise, the jaws of which should come about one inch from an outside punch mark. The piece is then bent by hammer blows to an angle of about 10 deg. The sample is then reversed and another bend of 10 deg. made, so that it appears as in Fig. 2. Care should be taken to keep these bends about one inch from the outside punch marks.

The sample is then placed between the jaws of the vise so that, when the

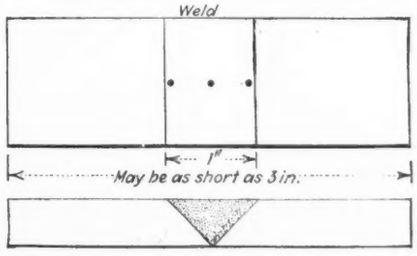



*Fig. 1—Sample weld prepared for ductility test*

vise is tightened, it is bent into the shape shown in Fig. 3. As soon as the first crack in the weld metal appears, the bending is stopped and the distance between the punch marks measured with a flexible steel scale reading in hundredths of an inch. Since these

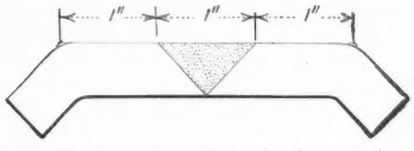



*Fig. 2—Sample as bent by hammering*

punch marks were originally one inch apart, the excess of this last measurement, read in hundredths, gives the percentage of elongation directly.

For the purposes of comparison, and to judge the ability of welders, tests

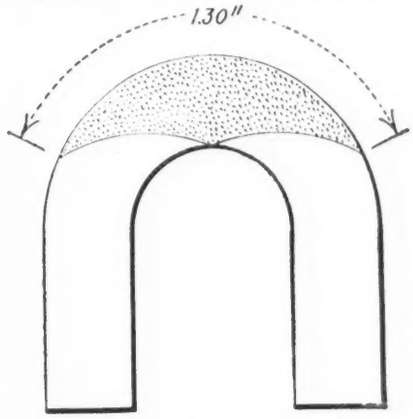



*Fig. 3—Sample after squeezing in vise, showing 30 per cent elongation in outside fibers of weld*

show that with welds made with mild steel rod in three-eighth inch boiler plate, the elongation is from 26 to 30 per cent. Special welds made with high-strength materials are less ductile, showing elongations of from 15 to 20 per cent. These figures are for the ordinary run of good welder's work and can be considered good standards for test purposes.

*Some Things an Engineer Should Know*

# ABOUT CONTRACTS

By Leo T. Parker
*Attorney at Law, Cincinnati, Ohio*

THE first important thing, when controversy over a contract develops, is to determine whether or not the agreement is valid and binding. Of course, if the contract is invalid and unenforceable, neither party is liable for failure to fulfill the terms of the agreement.

A contract is invalid if any of the following questions can be answered in the negative:

1. Did one party submit an offer which the other unconditionally accepted?
2. Did both parties agree absolutely to perform a definite act or thing?
3. Were both parties of legal age and of sound mind and did they have proper authority to enter into the contract?
4. Were the objects of the contract lawful?

Also, the law is well established that a purchaser may legally cancel any contract of sale obtained by a seller as a result of direct or indirect fraud, misrepresentation, coercion, undue influence, duress, threats, or where the contract is made without proper authority of the purchaser's employee, or while an authorized purchaser is mentally deficient, intoxicated, under influence of drugs, or under legal age. Moreover, there are certain kinds of contracts that are void, such as those that are against public policy, prohibited by a statute, such as those tending to effect immorality or having an illegal object.

Generally speaking, the distinction between void and voidable is that in the former neither party may compel the other to fulfill his obligations, whereas in the latter class the purchaser may use his pleasure in declaring the contract void or he may require the seller to fulfill his obligation.

A common source of litigation is where the property shipped does not conform with the samples displayed at the time of making the contract of sale. Of course, it is well established that a purchaser may always rescind a contract of sale and is not required to accept and pay for equipment ordered if the seller fails in any material way to fulfill the terms of the agreement.

On the other hand, a buyer cannot legally reject merchandise where the complaint is based upon a defect of little or no consequence (136 S. E. 602). Therefore, the outcome of litigations involving this point of the law often is dependent upon whether or not the complaint is material.

Where one party submits an offer, the other party must accept the proposal in all details, or a valid contract is not completed. However, if the recipient agrees to accept only portions of the proposal and to submit a modified offer, a valid contract is made if the party receiving the modified proposal accepts it in detail.

### When Accfptance by Letter Is Effective

Litigation sometimes results where a purchaser of equipment who has received an offer writes a letter of acceptance after the seller sends a letter withdrawing the offer. This may happen where the price of the commodity is unstable.

The law is established that when a letter properly addressed is deposited in a post-office or government letter box, the presumption is that the letter is received at that instant by the addressee. However, under certain circumstances the sender of a letter may have considerable difficulty in proving that the letter actually was mailed.

It has been held that where an offer is submitted by telegram, the recipient is legally bound to acknowledge or accept the offer immediately, generally the same day, otherwise the person who submits the offer is privileged to withdraw it.

On the other hand, where an offer is submitted by letter, which does not indicate great haste on the part of the person submitting the offer, the recipient is not bound to acknowledge it by the return mail or even the same day, unless requested to do so by the person who submits the offer.

### Guarantees by Manufacturer

A guarantee issued by a manufacturer is valid and enforceable. However, a guarantee issued by a salesman representing a manufacturer or seller is not valid unless the purchaser introduces convincing testimony to show that the salesman's employer did some act which led the buyer to believe the representative had authority to give a valid guarantee.

A recent Court explained that although an employer does not authorize his employee to enter into binding contracts and does not lead others to believe that his agent has such power, yet a contract made by the agent will be held valid if the employer fails to notify the other party within a reasonable time that the agent has exceeded his authority (285 S.W. 516).

Of course a salesman who gives a guarantee without authority from his employer is personally liable if the party to whom the guarantee is extended, desires to hold the salesman responsible (198 Mass. 212).

Moreover, contrary to general opinion a contract made by a salesman for the sale of equipment is not valid and enforceable by the purchaser until the salesman's employer accepts the order signed by his representative.

The law recognizes a salesman as a means of communicating to his employer offers made by those who place orders with the representative. If the seller desires, he may without liability refuse to fill the order, although the salesman has promised absolutely to fill the same at the price and quantity distinctly specified.

Conversely, a purchaser may cancel an order given to a salesman any time before the seller mails his letter of acceptance or actually ships the goods (287 S.W. 755).

In other words, unless there is a distinct agreement between a purchaser and a seller who employs the traveling representative that the salesman is authorized to bind the employer on contracts of sale or guarantees, neither the seller nor the buyer is legally bound by the contracts made by the salesman until the latter's employer accepts the order submitted by the purchaser.

### Written and Verbal Contracts

A contract may be written, oral, express, or implied. An oral contract is as effective as a written one, and both are governed by practically the same rules of the law. The important difference between a written and an oral contract is that the parties must introduce evidence to prove the contents of an oral contract, whereas the courts construe a written contract strictly in consideration of the written words. Moreover, "side" or verbal agreements have absolutely no effect to vary the meaning of a written contract.

As a matter of legal record many litigations have been entered by parties who are certain to lose the cases, not knowing that the courts will not permit introduction of verbal testimony to vary the meaning of a written contract. The only circumstances under which verbal testimony may be introduced to relieve a party from obligations of a written contract is to show fraud, unavoidable mistake, and the like, or to explain the meaning of ambiguous parts of the agreement.

# RECENT PUBLICATIONS

CODE FOR ELECTRICITY METERS. Prepared by a Joint Committee under the sponsorship of the Association of Edison Illuminating Companies, the National Electric Light Association and the United States Bureau of Standards, with Dr. J. Franklin Meyer, of the Bureau of Standards, as chairman. Third edition, 1928. Published by National Electric Light Association, New York City. Size 6x8⅞ in.; 132 pages. Price, $2.

THIS code was originally formulated in 1908, and in 1912 the second edition, when published, was generally recognized as the governing standard in this field. The 1912 edition of the code, with an added section on demand meters, which was formulated in 1920, was submitted to the American Engineering Standards Committee and approved as an American standard in July, 1922. About three years ago a general revision was undertaken, and the third edition was approved by the American Engineering Standards Committee as the current American standard on Feb. 20, 1928.

Throughout its life the "Code for Electricity Meters" has been developed by the joint efforts of the Association of Edison Illuminating Companies, the National Electric Light Association and the Bureau of Standards, and these three organizations have appeared as sponsors for the standard on both occasions when the current editions were approved as American Standards.

NIAGARA POWER. By Edward Dean Adams. Privately printed by The Niagara Falls Power Company, Niagara Falls, N. Y., 1927. Cloth; 8½x11 in.; illustrated; 1,098 pages in two volumes.

THERE are waterfalls that are higher than Niagara and there are those that may surpass it in beauty, but none exceed Niagara's volume of water or its power. Furthermore, no water power has contributed so much to industrial development as the great American cataract has. Notwithstanding this, it still retains its original splendor, which attracts hundreds of thousands each year from all parts of the world.

The history of water-power utilization may be said to have been made at Niagara Falls, and it is gratifying to know that this history has been recorded by those intimately connected with the work. These two volumes begin with the earliest knowledge that the white man had of these falls and comes down to the installation of the latest power project, which involves the largest powered hydro-electric units in the world.

Volume I deals with the early Niagara history and power projects, the evolution of the Niagara Falls Power Company and related and associated companies. A reading of this volume clearly indicates that the history of hydro-electric development and power transmission in this country has been written in no small part at Niagara Falls. This development represents a struggle for nearly three centuries to bring the power of Niagara under control and make it available to industry. The many attempts recorded in this volume show that it has been no easy task and one that, at one time, challenged the engineering talent of this country and Europe.

The construction and operation of the various plants at Niagara Falls form an interesting and important part of the world's water-power history. These are recorded in Volume II. The problems of machinery, power house and waterway design frequently led into unexplored regions of science and engineering and therefore involved much pioneer work. Another interesting side of the story is found in the operation of the stations. Not only does this problem include the handling of the equipment inside the plant, but the forces of nature must be contended with on the outside. One of the problems is that of handling the ice, and this story forms one chapter of the work.

There is also the human side of this history, and in this work the men whose vision, courage, engineering and financial ability made this great development possible, have not been left out of the picture. So many outstanding engineers and industrialists have at one time or another contributed to harnessing Niagara that one feels that these two volumes might be a biography of the world's leaders in these professions.

STORAGE BATTERIES. By Morton Arendt, Assistant Professor of Electrical Engineering, Columbia University. Published by D. Van Nostrand Company, Inc., 8 Warren St., New York City, 1928. Cloth; 6x9 in.; 285 pages; 156 illustrations; 30 tables. Price, $4.50.

STORAGE battery literature is replete with chemical and mathematical formulas, but in this book such treatment is of only a minor quantity. The author has emphasized the construction, application, operation and maintenance of the equipment. Only such theory as is actually necessary to account for reactions and cell characteristics has been considered. The influence of plate construction, purity of material and electrolyte diffusion, as primarily controlling cell behavior, has been given special attention.

A major portion of the attention given to the theory of the storage battery is confined to the second chapter, which treats of general theory. Chapter III, on lead-plate construction, shows the different designs and how they are constructed and gives the materials from which the plates are formed. The different kinds of sulphuric acid, specifications for electrolyte and for water, parts of water to one of acid to produce electrolyte of different specific gravities, typical sulphuric-acid electrolytes, effects of electrolyte specific gravity on ampere-hour capacity of lead batteries, and jelly or pulp forms of electrolyte are some of the subjects treated in Chapter IV.

The factors that influence the capacity and efficiency of a battery are treated under such headings as amount, arrangement and quality of active material; amount, specific gravity, distribution and purity of the electrolyte; rate of discharge, temperature, past performance, health and age of the cell. The chapter on installation, operation and maintenance deals largely with the faults that may develop in the lead battery, the cause of these troubles and how they are remedied.

One chapter is devoted to the nickel-iron alkaline type cells (the Edison type) and covers their construction, operation and care. The chapter on storage-battery testing includes such features as testing for impurities in the electrolyte, capacity, influence of temperature, loss of charge standing idle, etc. Storage-battery applications is the subject of the last chapter, which treats of eighteen different classes of applications.

The material is presented in an easily read form, and among those interested in storage batteries this book should find a wide clientele.

THE SIGNIFICANCE OF THE ELASTICITY AND THERMAL EXPANSION OF FIRE-CLAYS. By R. F. Geller, Bureau of Standards, Pittsburgh, Pa. Published by the American Refractories Institute, Cleveland Bldg., Pittsburgh, Pa. Paper; 6x9 in.; 14 pages. Price, 50 cents.

THIS pamphlet of fourteen pages covers a series of tests made in fireclays from Pennsylvania, Missouri and Kentucky, with regard to thermal expansion. The results should be of interest to all power-plant executives, since the thermal expansion of a fireclay or firebrick bears a close relation to the resistance to spalling.

GEORGIA POWER COMPANY YEAR BOOK 1927-1928 has recently been issued. This book, which contains 56 pages, is beautifully done in color. It comprises the history of the company; a brief story of hydro-electric development in Georgia; the interconnection of power systems, an outline of Georgia's resources and possibilities; labor available; education and recreation. A great deal of detailed information is included on manufacturing, power generation and distribution and raw materials in the state. The book has been presented to tell the story of the company and the opportunities in the state. Copies of the book may be obtained by addressing the company at Atlanta, Georgia.

# *Events and Men in Power's Field*

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

## Columbia System Increases Generating Capacity

### Additions to Columbia Park, Millersford and West End Stations will add 139,514 kva. in generating capacity

IN ORDER to provide for the expected increase in commercial load during 1928, the Columbia System has decided to increase the capacity of the present West End, Columbia, and Millersford Stations, instead of building a new generating station.

Four generators now at West End, rated 31,250 kva., will be replaced by four new generators which will each have a rating of 45,000 kva. The present turbine, operating at 250 lb. gage and 600 deg. total temperature, will be rebuilt to have a capacity of 40,000 kw. In ordering to obtain this increased output, it will be necessary to change the diaphragms and nozzles in the first few stages to allow a greater amount of steam to pass through them. In addition, a closed heater will be installed for each turbine for the purpose of heating feed water by steam extraction from the turbine. The increased generating capacity will also necessitate changes in the present switching equipment.

Two of the 31,250-kva. generators now operating at West End will be moved to the Columbia Station, where they will be direct-connected to two new high-pressure General Electric turbines rated at 16,000 kw., and operated with steam at 600 lb. pressure and 725 deg. F. total temperature. The steam from the new high-pressure unit will be exhausted at 185 lb. pressure and 490 deg. F. total temperature, and after having its temperature increased in a reheat boiler to 725 deg. F., it will be used to supply the present low-pressure units. The combined rating of the new units will be 74,000 kva. each. Provision will be made so that the low-pressure units may be operated from the high-pressure steam supply in case of a failure of the high-pressure unit.

In order to supply the additional amount of steam required by the new turbines, Bailey water-cooled front walls will be added to the seven rectangular boilers, thus permitting regular operation at higher rating. The boiler output will then be increased from 160,000 lb. of steam per hour to 200,000 lb. A new 70-ton pulverizer will be added to take care of the increased coal consumption.

At the Millersford Station there are at present two 12,500-kw. units and three 20,000 units. No. 6 turbine of 25,000 kw. capacity is now being installed, and will raise the total station capacity to 110,000 kw.

## Canadian Hydro Projects Total 550,000 Hp.

According to data just compiled by the Dominion Water Power and Reclamation Service, approximately 550,000 horsepower of turbine capacity will be installed in entirely new developments or in additions to existing hydro-electric stations in Canada during the present year. The large number of undertakings in the initial stages of construction and others in active prospect will, when completed within the next few years, result in an addition to the total installation in the Dominion of over 2,000,000 horsepower.

In British Columbia the Bridge River Power Company, a subsidiary of the British Columbia Electric Railway Company, is actively carrying on construction on a development which, when completed to its ultimately designed capacity of 500,000 hp., will be the largest in the province. At present a tunnel of 13,200 feet in length and 12 feet in diameter, is being driven from Bridge River to the power station site on Seton lake. It is planned to have the initial installation of two 28,000-hp. units completed by the end of 1930.

The West Kootenay Power & Light Company is actively carrying forward the construction of its new 60,000-hp. development on the Kootenay River at South Slocan. It is expected that this plant will be completed towards the end of this year. The West-Canadian Hydro Electric Corporation has commenced the construction of a plant of 2,000 hp. capacity on the Shuswap River from which power will be delivered to supply the city of Vernon and other nearby municipalities in British Columbia.

On the Winnipeg River in Manitoba the Manitoba Power Company is adding, during the present year, the last two units of 28,000 hp. each in its Great Falls station. This will bring the total installation in this station to its ultimate designed capacity of 168,000 hp. On the same river the city of Winnipeg has commenced preliminary work on the construction of a railway from Point du Bois to the site of a new development at Slave Falls. It is the city's intention to have the initial installation at Slave Falls completed by 1931 in order to take care of the expected growth of load by that time.

In Ontario the Ontario & Minnesota Power Company is completing its third plant on the Seine River. This development, which is situated at Calm Lake, will have an installed capacity of 13,200 hp., the energy from which will be transmitted to serve the pulp and paper mills at Fort Francis. On the Mattagami River in Northern Ontario, the Spruce Falls Company is making rapid progress with its development at Smoky Falls. The initial installation of 56,250 hp. is expected to be ready for operation by the beginning of September, this year when power will be transmitted to the company's pulp and paper mills at Kapuskasing. The International Nickel Company of Canada has initiated the development of 28,000 hp. at its Big Eddy dam on the Spanish River. It is expected to have the plant in operation some time in the spring of 1929.

On the Gatineau River in the province of Quebec, the Gatineau Power Company has brought well toward completion its development at Paugan Falls. The initial installation of six units of 34,000 hp. each is expected to be completed by September of the present year. This is all 25-cycle power and will go to serve the contract which the company has with the Ontario Hydro Electric Power Commission. The same company plans to add a fourth unit of 34,000 hp. to its Chelsea plant, a 24,000-hp. unit to the Farmers Rapids plant, and complete a second 25,000-hp. unit in its recently acquired Bryson plant on the Ottawa River.

On the Saguenay River, the Duke-Price Power Company has still two units to install in its Isle Maligne station to bring it to its ultimate designed capacity of 540,000 hp. One of these units will be installed before the end of this year.

The Montreal Island Power Company has recently let a contract for a 65,000-hp. development on Des Prairies River near Montreal. It is expected the initial installation of 40,000 hp. will be ready for operation in 1929.

On the Saint John River at Grand Falls, New Brunswick, the Saint John River Power Company is rapidly bringing to completion the construction of a hydro-electric development which will ultimately have a capacity of 80,000 hp.

## W. Pestell, of the Riley Stoker Corporation, Dies

William Pestell, vice-president and sales manager of the Riley Stoker Corporation, Worcester, Mass., died on July 10, in his 56th year. Mr. Pestell was stricken while on a business trip, being found dead in his Pullman berth as the train was entering New Orleans.

Mr. Pestell was born in Rutland, England. Since 1914 he was employed by the Riley Stoker Corporation, first as district manager, then as sales manager, and became vice-president in 1927. He was well known throughout the country in engineering and street-railway circles. Before going with the

*William Pestell*

Riley Stoker Corporation, he was superintendent of power for the Lynn & Boston Street Railway Company and superintendent of the power houses of the Rhode Island Company at Providence. He was connected for several years with the Allis-Chalmers Mfg. Company at Boston, and the J. G. White Engineering Corporation in New York. The Worcester Consolidated Street Railway Co. brought Mr. Pestell to Worcester as superintendent of power.

Mr. Pestell was a fellow of the American Institute of Electrical Engineers and member of the American Society of Mechanical Engineers. He belonged also to the Engineers Club of Boston, the Western Society of Engineers in Cleveland, the American Electric Railway Association.

## New Stand-by Station Planned for Berlin

Construction on the new 210,000-kw. Westmark stand-by station, which will be in operation only twelve hours a day, will begin in the early fall. Originally, it was planned to equip the plant with pulverized coal-fired high-pressure Benson boilers and large turbine units, but, owing to the high initial cost and the expectation of refractory trouble due to repeated shutdown and restarting of the furnaces, it was finally decided to adopt stokers for firing anthracite coal. The lower investment and lower furnace upkeep required fully justify this change, even at a sacrifice of over-all efficiency. Eight boilers will furnish steam at 312 lb. pressure absolute.

Six 35,000-kw. turbine-generators operating at 3,000 r.p.m. will generate three-phase, 50-cycle current at 10,000 volts. This will be stepped up to 30,000 volts for transmission, and the station output will be tied into the superpower system of central Germany.

## New Colorado River Commission to Meet July 30

The commission appointed by the Secretary of the Interior to investigate the Boulder Dam Project has been approved by the President and includes the following: Major William L. Seibert, D. W. Mead, Robert Ridgeway, Charles P. Berkey, and W. J. Mead.

Plans which will be followed by the new Colorado River Commission in its study of the feasibility of the Boulder Dam project will be mapped out at the initial meeting of the commission to take place July 30 in Washington.

As the commission must have its report ready to present to Congress Dec. 3, little opportunity will be offered for new field work. For that reason the study will have to be confined largely to existing data.

## Central Maine Power Plans to Develop Power on Kennebec

Construction work on the largest hydro-electric development in New England—a 60,000-hp. station, with a 90 ft. high dam, the whole to cost $7,000,000 and require three years to complete—will be started soon by the Central Maine Power Company on the upper Kennebec River a mile and one-half above the Town of Bingham in Somerset County.

The dam will extend back nine miles on the Kennebec, impounding five billion cubic feet of water. The power generated will add 190,000,000 kw.-hr. to the state's annual output.

Walter S. Wyman, president of the Central Maine Power Company, stated that work will be well under way before winter and rushed so that the new dam will be ready to impound water in the spring of 1931.

# Plans For American Participation in World Engineering Congress Progress

A NATIONWIDE movement to marshal a large delegation of engineers from the United States to attend the first World Congress of Engineers which will be held in Tokio during October, 1929, is now under way, it was announced by Maurice Holland, Executive Director of the American Committee, which is arranging for American participation in the international gathering.

Following a meeting of a special committee on promotion and attendance, headed by George W. Fuller, it is reported that engineers and engineering societies in the United States will be organized into units to co-operate in an effort to interest the engineering profession in the Congress in order that the United States will be represented at the meeting by a large delegation from this country.

Mechanical engineering, its progress and problems, is scheduled to play an important part at the Engineering Congress. On the technical program of the international meeting, which Dr. Elmer A. Sperry, chairman of the American Committee arranging for participation of American engineers, has received from Baron K. Furuichi, president of the Congress, is listed for discussion subjects of scientific and industrial interest covering in scope virtually every phase of engineering activity and development.

For mechanical engineers papers will include investigations of heat engines and boilers, hydraulic machinery, pneumatic machinery, machine tools and machines for manufacturing, machines for conveyance, ordnance, mechanism and machine design, heating and ventilation, and numerous other subjects that cannot be classified under the foregoing heads.

Doctor Sperry, whose precision instruments are well known and widely used in Japan, anticipates a large representation from the mechanical engineering profession will attend the Congress in view of the excellent opportunities the meeting will afford engineers to inspect the great industrial centers of Japan and the progress the island empire has made along mechanical engineering lines. There are over 20,000 enrolled engineers in Japan, a large proportion of whom are mechanical engineers.

A number of inspection trips have been planned, for those who wish to attend, throughout Japan and southern Manchuria. The scope of the technical program is international and embraces every phase of industrial engineering and scientific development.

The American technical program committee, of which Prof. Dugald C. Jackson is chairman, includes in its membership H. Foster Bain, Alex Dow, W. F. Durand, J. R. Freeman, Bancroft Gherardi, Allen Hazen, George W. Fuller, F. L. Hutchinson, Edgar Jadwin, A. E. Kennelly, D. S. Kimball, A. D. Little, F. R. Low, Michael I. Pupin, George T. Seabury, George Otis Smith, W. E. Wickenden and O. C Merrill.

## Coming Conventions

**American Society of Mechanical Engineers,** Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

**Canadian Steel and Power Show** at the University of Toronto Arena, Sept. 4-7; Campbell Bradshaw, secretary, 24 Front St., West Toronto, Canada.

**Midwest Power Conference and Exhibition,** at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

**National Association of Power Engineers,** annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

**National Association Practical Refrigerating Engineers,** annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

**New York Power Show** (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

**New England Water Works Association,** annual convention at Montreal, Canada, Sept. 18-21, Frank J. Gifford, secretary, 715 Tremont Temple, Boston, Mass.

**Stoker Manufacturers Association,** fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

**Second Bituminous Coal Conference** will be held at Pittsburgh, Nov. 19-22.

**Universal Craftsmen Council of Engineers,** annual convention and power engineering exhibition to be held at Newark, N. J., Aug. 7-10. Secretary, O. R. Young, 150 Nassau St., N. Y.

**World Power Fuel Conference** at the Imperial Institute, London, Sept. 24 to Oct. 6.

## Personals

HENRY B. LEE, resigned recently as chief engineer of the Lee steam turbine division of the D. E. Whiton Machine Company, New London, Conn., to enter the field of steam specialties.

GRANT B. SHIPLEY, engineer, of Pittsburgh, Pa., has recently been elected a director of the Mond Nickel Company, Ltd., of England and Canada.

DR. EDWARD DEAN ADAMS, engineer and financier, of New York, has received an honorary doctorate from the University of Louvain, and has been made Commander of the Order of the Crown by the Belgian government. Doctor Adams represented the Engineering Foundation at the dedication of the Louvain Library and Engineers' memorial carillon and clock on July 4. He was chairman of the committee on war memorial to American engineers.

BLAKE R. VANLEER, assistant professor of mechanical engineering in the University of California, has been appointed assistant secretary of the American Engineering Council, succeeding A. C. Oliphant, who has resigned.

CHARLES D. BARCLAY, of the Ralston Purina Company, St. Louis, Mo., has been elected president of the St. Louis Association No. 2 of Missouri, of the National Association of Power Engineers. Mr. Barclay will also serve as a delegate to the national convention in Detroit during September.

WELLS M. STANLEY, general manager of the Gulf Power Company, was recently promoted by the Alabama Power Company to manager of sales. Other promotions made by the company include, R. W. Williamson, manager of the Western division to general manager of the Gulf Power Company; Henry Maulshagen, district manager at Gadsden, to manager of the Western division, and C. A. Kittredge, of the office of distribution, to district manager at Gadsden.

KENNETH M. IREY, of Monmouth, Ill., has been appointed to the National Coal Association Research Fellowship at the Carnegie Institute of Technology and the United States Bureau of Mines to determine the composition of tar produced in the low-temperature carbonization of Eastern coals. The work will be along lines similar to those developed by preceding National Coal Association Fellowships, working on low-temperature tar from a Western coal.

## Business Notes

ANDERSON ENGINE & FOUNDRY COMPANY, Anderson, Ind., announces the opening of a complete sales and service branch at 1829 Exchange Building, Memphis, Tenn.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., at a recent meeting of the board of directors elected to the office of honorary vice-president the following officials: J. R. Lovejoy, George F. Morrison and B. G. Tremaine.

THE FAFNIR BEARING COMPANY, New Britain, Conn., is extending its plant by the addition of a new one-story building, 120 by 60 ft., and a 60-ft. addition to an existing six-story wing of the present factory. The new building will house a thoroughly modern hardening department, and the six-story addition will enlarge the working capacity of several of the manufacturing departments.

CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., announces the appointment of W. S. Lynch, formerly district manager at Seattle, Wash., as district manager of the Cincinnati office, Pearl and Vine Streets, to succeed T. G. Smallwood, who has been granted an indefinite leave of absence on account of ill health. A. M. Andresen has been appointed acting district manager at Seattle.

THE BOILER TUBE COMPANY OF AMERICA, 3125 Preble Avenue, Pittsburgh, Pa., has purchased the assets of the Johnson-Peter Company, of Pittsburgh, Pa., and Brooklyn, New York, distributors of Tyler lapweld steel, charcoal-iron boiler tubes and seamless-steel boiler tubes.

THE NATIONAL FLUE CLEANER COMPANY, INC., of Groveville, N. J., has recently appointed the following Southern representatives: Fuel Efficiency Engineering Company, American Trust Building, Birmingham, Ala; A. S. Furtwangler, 4 South Broad St., Charleston, South Carolina; Reed & Duecker, Inc., 171 North Main St., Memphis, Tenn.; Buckmaster-Luck-Malochee, Inc., Industrial Homestead Building, New Orleans, La., and Henry Eggelhof, Construction Industries Building, Dallas, Tex.

THE CARRIER ENGINEERING CORPORATION, 750 Frelinghuysen Ave., Newark, N. J., has purchased the four-story factory and office building at 850 Frelinghuysen Ave., formerly occupied by the General Electric Company, Edison Lamp Works Division.

THE ENTERPRISE MACHINE COMPANY, Middletown, Ohio, announces that it has taken over the manufacturing

## Fuel Prices

### COAL

**The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:**

| Bituminous (Net Tons) | Market Quoting | Price per Ton |
|---|---|---|
| Navy Standard | New York | $2.35@$2.50 |
| Kanawha | Columbus | 1.25@ 1.60 |
| Smokeless | Cincinnati | 2.00@ 2.25 |
| Smokeless | Chicago | 1.75@ 2.00 |
| S. E. Kentucky | Chicago | 1.30@ 1.60 |
| Steam | Pittsburgh | 1.40@ 1.80 |
| Gas Slack | Pittsburgh | 1.10@ 1.20 |
| Big Seam | Birmingham | 1.25@ 1.75 |
| **Anthracite** (Gross Tons) | | |
| Buckwheat | New York | $2.50@$3.00 |
| Birdseye | New York | 1.60 |

### FUEL OIL

**New York**—July 19, f.o.b. Bayonne, N. J.: 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

**St. Louis**—July 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.35 per bbl.; 26@28 deg., $1.40 per bbl.; 28@30 deg., $1.45 per bbl.; 30@32 deg., $1.40 per bbl.; 32@36 deg., gas oil, 4.15c. per gal.; 38@40 deg., 4.98c. per gal.

**Pittsburgh**—July 10, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., 5¾c. per gal.

**Philadelphia**—July 10, 26@30 deg., $2.07 per bbl.; 13@19 deg., $1.22 per bbl.; 22 plus, $1.48@$1.55 per bbl.; 27@30 deg., $2.17 per bbl.

**Cincinnati**—July 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal

**Chicago**—July 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.: 22@26 deg., 60@62½c. per bbl.; 26@30 deg., 75@80c. per bbl.; 30@32 deg., 90@95c. per bbl.

**Boston**—July 17, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@32 deg., 5½c. per gal.

**Dallas**—July 17, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

rights of Long-Reach soot blower formerly manufactured by the Long-Reach Soot Blower Company, 725 Ridgelawn Ave., Hamilton, Ohio.

THE D. E. WHITON MACHINE COMPANY, New London, Conn., announces the appointment of W. E. Beaney as chief engineer of the Lee steam turbine division.

## TRADE CATALOGS

INDUSTRIAL LOCOMOTIVES.—The day of the yard gang pushing cars has about disappeared. In place of the boys the gasoline-engine locomotive now does the shunting. Those who are interested in cheap switching will find much information in the Bulletin 2824 just issued by the Geo. D. Whitcomb Company, Rochelle, Ill., covering its gasoline-engine industrial locomotives.

VACUUM - TUBE SYNCHRONIZING EQUIPMENT.—This new publication of the General Electric Company, Schenectady, N. Y., contains eight pages dealing with vacuum-tube equipment for synchronizing high-voltage lines.

WELDED PIPING.—"Oxwelded industrial piping" is the title of a recent publication of the Linde Air Products Company, 30 East 42nd St., New York City. The bulletin describes and explains the economies in construction, repair and maintenance of welded pipe systems and is profusely illustrated.

CENTRIFUGAL PUMPS FOR HIGH PRESSURES.—Someone has said that a salesman's work in obtaining an order for machinery is half done when the prospect receives a well illustrated catalog printed in attractive colors on high-grade paper. If this be true, the Cameron pump salesman has a sinecure, for the new catalog on the Cameron multi-stage pump, just issued by Ingersoll-Rand Company, New York City, is one of the most attractive catalogs of recent months.

MOTOR-DRIVEN MINE HOISTS.—A 26-page bulletin has recently been issued by the General Electric Company, Schenectady, N. Y., which gives a partial list of the motors supplied by that company for mine-hoist installations, up to May 1, 1928. This bulletin also contains a list of the factors that are required for preparing estimates on mine-hoist equipment.

POINTER DRAFT GAGES.—The new and improved dial-type pointer draft gage of Ellison Draft Gage Company, Chicago, Ill. is described in Bulletin 11 recently issued. The gage, which is built in the single- and double-pointed types, is of unusually substantial construction with large scale of excellent visibility, with black graduation and figures $\frac{3}{16}$ in. high.

WAGNER ELECTRIC CORPORATION, 6400 Plymouth Ave., St. Louis, Mo., has just issued bulletin 156 on Wagner Bearing Construction, in which the Wagner improved sleeve bearing and the Wagner ball bearing construction are fully described and illustrated. The improved sleeve bearings are completely sealed against the entrance of dust and dirt or the escape of oil. The ball bearing construction is of the double-cap type, a construction facilitating replacement or servicing, and makes it possible to remove or assemble ball bearings in a dust-laden atmosphere without danger of injurious foreign matter getting into the bearing.

APPLICATIONS OF DIESEL ENGINES—A series of catalogs dealing with the use of Diesels in particular industries, such as irrigation, sugar mills and iron mines, has been published by the Fulton Iron Works Company, St. Louis, Mo. Those interested in the cost of power in any industry can obtain the proper pamphlet by writing to the engine builder.

# *New Plant Construction*

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Calif., Los Angeles**—Southern California Edison Co., J. B. Miller, Pres., 306 West Third St., had preliminary plans prepared for a 12 story office building including electrical heating system, electric elevators, etc. at Old Fifth St. and Grand Ave. Estimated cost $2,000,000. Allison & Allison, 1005 Hibernian Bldg., are architects.

**Calif., Oakland** — Corporation being organized, awarded contract for a 20 story office building at 14th and Harrison Sts., to Cahill Bros., 206 Sansome St., San Francisco. Estimated cost $1,500,000.

**Calif., Watsonville**—Apple Growers Storage Co., awarded contract for the construction of a cold storage plant on Beach Rd., to Gay Engineering Co., 2650 Santa Fe Ave., Los Angeles. Estimated cost $200,000.

**Colo., Denver**—Montgomery Ward & Co., G. B. Everett, Pres., Chicago Ave., and Larr St., awarded contract for an 8 story mail order plant at South Broadway and Virginia Ave. here, to Wells Bros. Construction Co., 53 West Jackson Blvd., Chicago. Estimated cost $1,300,000 to $1,800,000.

**Ga., Atlanta** — City, H. C. McCutcheon, City Hall, Chn., will soon award contract for a 15 story city hall including steam heating system, elevators, etc., at Washington and Mitchell Sts. Estimated cost $1,250,000. G. Lloyd Preacher & Co., Wynne Claughton Bldg., are architects.

**Fla., Miami**—Burdine Inc., East Flagler St., is having sketches made for the construction of an electric power plant at S. E. First St. Estimated cost $80,000.

**Ill., Chicago**—A. S. Alschuler Inc., 28 East Jackson Blvd., Archt., will soon receive bids for a 19 story office and stores building at Wabash Ave. and Harrison St. for H. Rubloff, 10 South La Salle St. Estimated cost $2,000,000.

**Ill., Chicago**—J. Rosenwald, 4901 Ellis Ave., is having sketches made for the construction of an apartment building at Michigan and Wabash Aves. and 46th to 47th Sts. Estimated cost $2,500,000. Klaber & Grunsfeld, Jr., 431 North Michigan Ave., are architects.

**Ill., Lawrenceville**—England Pond Drainage Dist., G. W. Lackey, Atty, will soon award contract for the construction of a drainage pumping station including pumps, engines, etc.

**Ind., New Harmony**—City, J. Rutledge, Clk., will receive bids until July 31 for remodeling power plant and installation of 180 hp. oil engine. W. S. Heer Engineering Co., 413 Terre Haute Trust Bldg., Terre Haute, Ind., is engineer.

**Ia., Neola**—City, F. H. Liddell, City Hall, Clk, will soon award contract for the construction of a sewage disposal plant including pump house, pumps, etc. Nixon & Reynolds, 309 Omaha Grain Exchange Bldg., Omaha, Neb., are engineers.

**Ia., Pisgah**—City plans an election Aug. 16, to vote bonds for waterworks improvements including deep well, pumping equipment, tank on tower, etc. W. E. Buell & Co., Grain Exchange Bldg., Sioux City, are engineers.

**Ia., Primghar**—City, W. Downing, Mayor, will soon award contract for waterworks improvements including addition to pump house, one 100 g.p.m. triplex or duplex pump, 10 hp. motor, etc. W. E. Buell & Co., Sioux City, are engineers.

**Mass., Boston**—Boston Lying-In Hospital, L. Bachelder, Ch. Bldg. Committee, 431 Massachusetts Ave., awarded contract for the construction of a 5 story addition to hospital at 221 Longwood Ave., to Stone & Webster Inc., 49 Federal St. Estimated cost $1,000,000.

**Mass., Fall River**—Mohican Hotel Co., W. Durfee, 80 Main St., plans the construction of a hotel at North Main and Central Sts. Estimated cost $1,000,000. J. M. Darling, North Main St., is architect.

**Mass., Springfield**—City will soon award contract for the construction of North End pumping station, McClintock & Craig, 458 Bridge St., is engineer.

**Mich., Detroit**—Detroit Edison Co., 2000 Second Blvd., plans the construction of a sub-station on Rademacher Ave. Estimated cost $400,000. Private plans.

**Missouri** — Missouri Power Co., having surveys made for the construction of a power dam on Sac River in St. Clair county.

**Mo., Bismarck** — City plans an election soon to vote $47,000 bonds for waterworks improvements including deep well, pump house, pumping equipment, etc. Russell & Axon, 1945 Railway Exchange Bldg., St. Louis, Mo., are engineers.

**Mo., St. Louis** — Arlington Investment Co., c/o Manske & Bartling, 410 North Euclid Ave., Archts., plans the construction of a 15 story office building at 14th and Olive Sts. Estimated cost $1,000,000.

**Mo., St. Louis**—Continental Life Insurance Co., E. Mays, Pres., 10th and Olive Sts., plans the construction of a 20 story office building including steam heating system, etc. at Olive St. and Grand Blvd. Estimated cost $1,500,000. W. B. Ittner, 911 Locust St., is architect.

**Mo., St. Louis**—W. H. and N. Cunliff Co., 410 North Euclid Ave., will build a 15 story hotel at Northwest 15th and Olive Sts. Estimated cost $1,000,000. Owner is general contractor.

**Mo., St. Louis**—Local Syndicate, c/o W. J. Abbott, 806 Chestnut St., is having preliminary plans prepared for a 25 story hotel and apartment building including steam heating system, etc. at Lindell Blvd. W. and Euclid Ave. Estimated cost $2,000,000. J. L. Bowling and I. Shank, Arcade Bldg., are architects.

**Mo., St. Louis**—Local Syndicate, c/o W. R. Orthwein, Boatmen's Bank Bldg., awarded contract for a 16 story hotel at 12th and Locust Blvds. to McKelvey-Carter Construction Co., 3800 West Pine Blvd. Estimated cost $1,250,000.

**Neb., Gering**—Union Pacific R.R. Co., 15th and Dodge Sts., Omaha, awarded contract for a group of terminal building including 26 x 34 ft. boiler room, 28 x 30 ft. oil pump house, etc., here. to T. J. Allen, Scottsbluff.

**N. J., Belleville** — Bd. of Chosen Freeholders, Hall of Records Bldg., Newark, awarded contract for the construction of a laundry and power house at Essex County Hospital here, to Hoppe & Schroeder Inc., 1009 18th Ave., Newark.

**N. J., Newark**—Lefcourt Realty Holdings, 1351 Broadway, New York, N. Y., will build a 30 story office and hotel building including steam heating system, etc., at South Canal, Mulberry and Commerce Sts. Estimated cost $10,000,000. F. Grad, 1023 Broad St., is architect. Work will be done by separate contracts.

**N. J., Newark**—Steuben Club of Newark Inc., 43 Central Ave., is having revised plans prepared for an 8 story club, store and theatre building including steam heating and ventilation systems, boilers, elevators, etc. on Washington St. Estimated cost $1,000,000. Ferdinand H. Koenigsberger, 48 Walnut St., is architect.

**N. Y., New Yorg**—American Museum of Natural History, H. T. Osborn, Pres., is having sketches made for the construction of a museum at 77th St. and Columbus Ave. Total estimated cost $4,500,000. Trowbridge & Livingston, 527 5th Ave., are architects.

**N. Y., New York**—New York Edison Co., 130 East 15th St. had plans prepared for 50 x 99 ft. addition to sub-station at 123 East 83rd St. Estimated cost $200,000. W. Whitehill, 708 6th Ave., is engineer.

**N. Y., New York**—Three Hundred Sixty Eight Lexington Ave. Inc., F. J. Schoonmacher, Pres., 342 Madison Ave., plans the construction of a 22 story office and stores building at 116 East 41st St. Estimated cost $3,250,000. Moore & Landsiedel, 509 Willis Ave., are architects.

**N. Y., Ossining** — Northern Westchester Lighting Co., is having plans prepared for the construction of two sub-stations. Estimated cost $170,000. T. E. Murray, 55 Duane St., New York, N. Y., is architect and engineer.

**O., Painesville**—City, R. M. Evans, Mgr., is having plans prepared for the construction of a municipal light plant. Estimated cost $75,000. Hadlow, Hughes, Hick & Conrad, 1301 Union Mortgage Bldg., Cleveland, are architects and engineers.

**Pa., Philadelphia** — R. M. Dippy, 1600 Walnut St., Archt., is preparing plans for a 20 story apartment building at 19th and Pine Sts. Estimated cost $1,500,000. Owner's name withheld.

**Pa., Philadelphia**—Strawbridge, Clothier Co., 8th and Market Sts., awarded contract for the construction of a department store to Turner Construction Co., 1700 Walnut St. Estimated cost $7,000,000.

**Pa., Philadelphia** — West Philadelphia Stock Yards, E. B. Shriver, Pres., 30th and Race Sts., plans the construction of an abattoir and office building at 36th and Grays Ferry Rd. Estimated cost $1,000,000.

**Tenn., Memphis** — Bank of Commerce & Trust Co., T. O. Vinton, Pres., Bank of Commerce Bldg., plans the construction of a bank and office building at Second and Monroe Sts. Estimated cost $1,000,000. Hanker & Cairns, Court Sq. Bldg., are architects.

**Texas**—Central Power & Light Co., Frost Bldg., San Antonio, awarded general contract for the construction of a power dam on Devils' River in Val Verde county to L. E. Myers Co., Harlingen. Estimated cost $300,000.

**Tex., Dallas** — Brinkerhoff & Bennett, American Exchange Bank Bldg., awarded contract for an 8 story medical building at Jefferson, Madison and Bishop Sts. to A. J. Rife Construction Co., 614 Largent St.

**Tex., Houston**—W. C. Hedrick & Gottlieb, 2008 Post Dispatch Bldg., Archts., will soon receive bids for a 15 story theatre and office building, for Houston Theatre Corp., c/o W. C. Biddle, 1219 Post Dispatch Bldg. Estimated cost $2,350,000.

**Tex., San Angelo**—B. B. Hail, of West Texas Lumber Co., awarded general contract for a 14 story hotel to R. E. McKee, 1916 Texas St., El Paso. Estimated cost $1,000,000. Steam heating, ventilation and refrigeration systems, boilers, elevators, etc., will be installed.

**Wash., Yakima**—Ross Bldg., Inc., will receive bids about Aug. 1 for a 7 story office and stores building at South Second and Chestnut St. Estimated cost $700,000. Stuart & Wheatley, Walker Bldg., Seattle, are architects.

**B. C., Vancouver**—Miller, Court & Co. Ltd, 736 Granville St., plans the construction of a 10 story office building at Pender and Howe Sts. Estimated cost $750,000.

**Ont., Ottawa** — Famous Players Corp., Royal Bank Bldg., Toronto, will soon award contract for the construction of a theatre building including steam heating and ventilation systems, etc., on Sparks St. here. Estimated cost $1,250,000. T. W. Lamb, 644 8th Ave., New York, N. Y. and C. Helm, c/o G. B. Caldwell, Bank St., Chambers, Ottawa, Ont., are architects.

**Ont., Toronto**—Syndicate, c/o N. A. Armstrong & Co., 7 King St. E., Archts., is having sketches made for an 18 story hotel including steam heating system, elevators, etc. at Leader Lane and King St. E. Estimated cost $1,000,000.

**Que., Hull**—Gatineau Power Co., is having plans prepared for the construction of a switching station at Val Tetreau. Estimated cost $75,000 to $100,000.

**Mexico, Tia Juana** — W. G. Bowman, Commonwealth Bldg., San Diego, Calif., awarded contract for a 12 story hotel here, to E. F. Rodriguez, Tia Juana, Mexico. Estimated cost $750,000.

## Equipment Wanted

**Air Compressor**—City of Cleveland, O., W. R. Hopkins, Mgr., will receive bids until July 25 for a portable air compressor complete with tools.

**Boiler** — City of Painesville, O., R. M. Evans, City Mgr., one 575 hp. boiler for municipal light plant.

**Boiler, Stokers, Feed Water Heater, Etc.** —E. Johnson, City Auditor, Chillicothe, Mo., will receive bids until July 28 for one 500 hp. water tube boiler with superheater, stoker and other accessories, also one 1500 hp. feed water heater, etc.

**Electrical Equipment** — Dept. of Mental Hygiene, L. M. Farrington, Secy., Albany, N. Y., will receive bids until Aug. 15 for equipment for two double end steel Diesel electrical ferryboats for Manhattan State Hospital, Ward's Island, New York, N. Y.

**Electrical Equipment**—Detroit Edison Co., 2000 Second Blvd., Detroit, Mich., plans to purchase electrical equipment for proposed sub-station on Rademacher Ave. Estimated cost $400,000.

**Engine**—City of New Harmony, Ind., J. Rutledge, Clk., will receive bids until July 31 for the installation of a 180 hp. oil engine for power plant.

**Engine**—Town of Durant, Miss., L. J. Wilkes, Clk., will receive bids until Aug. 7 for a 350 hp. Diesel engine direct connected to generator, 3 ph., 60 cycle, 2,300 v. with exciter.

**Engine, etc.**—City Council plans the installation of an engine for auxiliary power in proposed pumping station. Estimated cost $25,000.

**Generator Unit**—Central Power & Light Co., Frost Bldg., San Antonio, Tex., 10,000 kw. turbo-generator unit, etc., for power plant at La Lalma, Tex. Estimated cost $150,000.

**Generator and Exciter**—Mason & Parker Mfg. Co., Winchendon, Mass., is in the market for a generator and exciter, 220 v., 3 ph. a.c., 200-300 kilo-volt amp., also hydraulic wheel governor.

**Pumping Equipment**—City of Waukesha, Wis., will receive bids until July 27 (extended date) for pumping equipment, etc. for proposed sewage disposal plant.

**Pumping Equipment**—South Park Commissioner, M. E. Connelly, Secy., 57th St. and Cottage Grove Ave., will receive bids until Aug. 1 for furnishing and installing sewage pumping equipment in Grant Park.

**Pumping and Electrical Equipment** — Mayor and Council of Borough of Fair Lawn, N. J., will receive bids until Aug. 14 for furnishing and installing pumping and electrical equipment, etc., for proposed water distribution system.

**Pumping Units**—M. G. James, City Secy., Dallas, Tex., will receive bids until Aug. 10 for two 15 m.g.p.d. turbine-driven pumping units complete with auxiliaries, three 15 m.g.p.d. motor-driven pumping units complete with motors, two 750 kva. turbo-generators complete with auxiliaries and three 300 hp. water tube boilers.

**Pumps and Motors**—Bd. of Trustees, O. W. Bowers, Pres., Salem, Ind., will receive bids until Aug. 6 for electrically driven water pumps and electric motors for proposed waterworks improvements.

**Refrigeration Equipment**—Dept. of Mental Hygiene, Albany, N. Y., will receive bids until Aug. 8 for refrigeration equipment for New York State Psychiatric Institute, New York, N. Y.

## Industrial Projects

**Ga., Cartersville** — ORE WASHING PLANT—Georgia Manganese & Iron Co., Atlanta, plans the construction of a plant for hydraulic washing of ore here. Estimated cost $250,000. Perin & Marshall, 40 West 40th St., New York, are engineers.

**N. J., Jersey City** — PASTEURIZING PLANT—Peak Products Co., c/o C. H. Ziegler, 75 Montgomery St., Archt., will soon award contract for a 2 story, 80 x 100 ft. pasteurizing plant on Monmouth St. Estimated cost $100,000.

**N. J., Kearney**—ELECTRIC MANUFACTURING PLANT—Western Electric Co., M. Melin, in charge, 195 Broadway, is receiving bids for a 7 story factory on Central Ave. Estimated cost $1,200,000. Private plans.

**N. J., Paterson**—DYE FACTORY—H. H. Brown & Sons, 15 4th Ave., awarded contract for a 1 story, 55 x 75 ft. factory and boiler house to J. Yorna, 1 Jane St. Estimated cost $40,000.

**N. Y., New York**—METAL BOX FACTORY—Columbia Metal Box Co., 228 East 114th St., will soon award contract for the construction of two factory buildings. Estimated cost $100,000. George A. Bagge & Sons, 157 East 44th St., are architects.

**O., Ashtabula** — RUBBER FACTORY—Aetna Rubber Co., S. T. Campbell, Pres. and Gen. Mgr., 815 East 79th St., Cleveland, had plans prepared for three 1 story factory buildings here. Estimated cost $100,000. Private plans.

**O., Cleveland**—BUMPER FACTORY—The Eaton Bumper & Spring Service Co., 6515 Carnegie Ave., awarded contract for a 1 story, 42 x 90 ft. factory to Dresser Co., The Arcade. Estimated cost $40,000.

**O., Cleveland** — DYE FACTORY — Erie Dyeing & Processing Co., 2765 East 55th St., had plans prepared for a 1 story, 67 x 90 ft. addition to factory. Estimated cost $40,000. A. F. Janowitz, 811 Prospect Ave., is architect.

**O., Cleveland**—PACKING PLANT—Hildebrandt Provision Co., H. A. Hildebrandt, Secy. and Treas., 3620 Clark Ave., awarded contract for a 3 story, 105 x 127 ft. packing plant to Boldt-Rapp Co., 5511 Euclid Ave. Estimated cost $150,000.

**O., Cleveland**—TOOL FACTORY—Vlchek Tool Co., F. J. Vlchek, Pres., 3000 East 87th S., awarded contract for a 1 story, 30 x 60 ft. factory and 1 story, 40 x 102 ft. storage building to Hunkin-Conkey Construction Co., Hunkin-Conkey Bldg. Estimated cost $40,000.

**Okla., Wewoka**—SAFETY APPLIANCE FACTORY—National Safety Mfg. Co., is having preliminary plans prepared for a 1 story, 100 x 180 ft. factory for the manufacture of safety appliances for oil field work on Cedar St. Estimated cost $100,000. Architect not selected.

**Pa., Creighton**—GLASS PLANT—Pittsburgh Plate Glass Co., c/o Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, awarded contract for a 1 story glass plant here to Mellon Stuart Co., Oliver Bldg., Pittsburgh. Estimated cost $1,000,000.

**Pa., Meadville** — RAYON FACTORY — The Viscose Co., Marcus Hook, awarded contract for the construction of several manufacturing buildings here, to J. P. Pettyjohn Co., Lynchburg, Va. Estimated cost $1,000,000.

**Tex., Dallas**—HOSIERY MILL—Morten-Davis Co., E. W. Morten, Jefferson Hotel, had plans prepared for a 1 story, 105 x 156 and 45 x 45 ft. hosiery mill on Maple Ave. Estimated cost $55,000. W. Scott Dunne, 306 Melba Bldg., is architect.

**Ont., Toronto**—MALTING PLANT AND GRAIN ELEVATOR—Canada Malting Co., Royal Bank Bldg., awarded contract for the superstructure of a 4 story, 150 x 200 ft. malting plant and 80 x 190 ft. grain elevator. Estimated cost $500,000. John S. Metcalfe Co., 434 St. Francois St., Montreal, Que. is engineer.

**Ont., Toronto**—STEEL FABRICATING WORKS—Dominion Bridge Co., Reford Bldg., is having plans prepared for a 1 story addition to steel fabricating works on Sorauren Ave. Estimated cost $150,000. Private plans.

**Ont., Toronto** — PRINTING and ENGRAVING PLANT—Photo-Engravers Ltd, 249 Spadina Ave., will soon award contract for a 5 story, 40 x 140 ft. printing and engraving plant. Estimated cost $100,000. M. Brown, Confederation Life Bldg., is architect.